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A REPORT TO CONGRESS ON WATER POLLUTION CONTROL MANPOWER DEVELOPMENT AND TRAINING ACTIVITIES

ENVIRONMENTAL PROTECTION AGENCY

MARCH 1972

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A REPORT TO CONGRESS
ON WATER POLLUTION CONTROL
MANPOWER DEVELOPMENT AND TRAINING ACTIVITIES

THE ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER PROGRAMS
WASHINGTON, D.C.

MARCH 1972

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A REPORT TO CONGRESS
ON WATER POLLUTION CONTROL
MANPOWER DEVELOPMENT AND TRAINING ACTIVITIES

By

The Environmental Protection Agency
Office of Water Programs
Washington, D.C. 20460

March, 1972

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SUMMARY OF REPORT

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SUMMARY OF REPORT

Introduction

The Environmental Protection Agency (EPA) administers a water pollution control program in accordance with the provisions of the Federal Water Pollution Control Act of 1970 (P.L. 91-224).[1] This program includes a broad spectrum of activities related to water pollution control that are conducted in partnership with the States and local governments, private organizations and other Federal Agencies. Generally, the Federal legislation provides that the States and their subdivisions have primary responsibility for conduct of water pollution control activities, with financial and technical assistance from the Federal Government.

This report focuses on the manpower development activities of all organizations, both public and private, that are concerned with water pollution control. Educational institutions are added to indicate the breadth of training resources and requirements.

The report finds that manpower demands are expected for a wide variety of educational and skill categories from numerous sources and types of organizations. Training activities extend over a broad spectrum of occupational categories through a host of varied programs, both public and private. Given the broad scope of manpower and training activities, several considerations and qualifications should be noted before proceeding with a more detailed summary.

The report presents 5-year projections for increases in jobs in the water pollution control field. These projections represent EPA's best estimates of future job opportunities in water pollution abatement, and have been drawn from a variety of sources as explained in the report. EPA believes that they indicate the order of magnitude of the problem although they are subject to further refinement as additional information becomes available.

The report does not project the numbers of individuals who may become available for these jobs. This is a difficult task owing to the wide variety of professions and skills that will be recruited from an even greater number of institutions, locations, and educational backgrounds. As a consequence, it is not possible to estimate precisely at this time what the training needs will be nor where they will originate. While many programs that provide training may be worthy of expansion there has been insufficient analysis performed on present personnel and how they gained their knowledge to know if these sources will not continue to be sufficient in future years. Furthermore, to the extent that governmental programs are concerned, there is insufficient understanding about what private resources will be allocated to provide or acquire training to supplement public funding.

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[1] Hereinafter referred to as the Act.

It should be noted that even with a rigorous program of construction of new plants, wastes may not be treated at planned levels due in part to shortages of well trained personnel. This problem results partly from the absence of adequate State certification standards governing the minimum acceptable skill levels of operators, and the general level of salaries and wages for waste treatment operators. Often these problems can be traced to the general structure and level of wages and salaries among State and municipal governments.

To improve the ability of State and local governments to meet their many needs and desires, the President has proposed a program of revenue sharing. This program is designed to provide fiscal relief to State and local governments and to strengthen these institutions in dealing with complex problems and difficult situations.

With these considerations in mind, we may turn to the report and the summary of results of this study. The report is in five parts including a short introduction. Part II discusses manpower planning; Part III manpower recruitment, retention, and utilization; and Part IV manpower training. In specific response to the requirement of subsection 5(g)(4) of the Act, setting forth the items to be covered in this report, Part II includes a report on actions taken under subsection 5 (g)(2) to develop a forecasting system for manpower and training needs and provides interim estimates of future needs. Also responding to the statute, Part IV includes a discussion of EPA actions taken under subsections 5(g)(1) and (3) and comments upon the extent and effectiveness of non-EPA training programs in the field of water pollution control. Finally, Part V of this report sets forth conclusions.

This "Summary of Report" parallels in structure the presentation of the entire report.

Manpower Planning

The size and complexity of the water pollution control manpower universe is defined by a number of factors:

- The current large number of jobs (1971 estimate 149,400).
- The projected rapid growth in jobs (1976 estimate 254,200).
- The large number of employers (1971 estimate 25,000 public and private).
- The geographic dispersion of jobs throughout the Nation.
- The large number of different occupational categories that constitute the universe of jobs (EPA had identified 144 different occupations).
- The changing technology that affects the nature of the work performed by many employees.

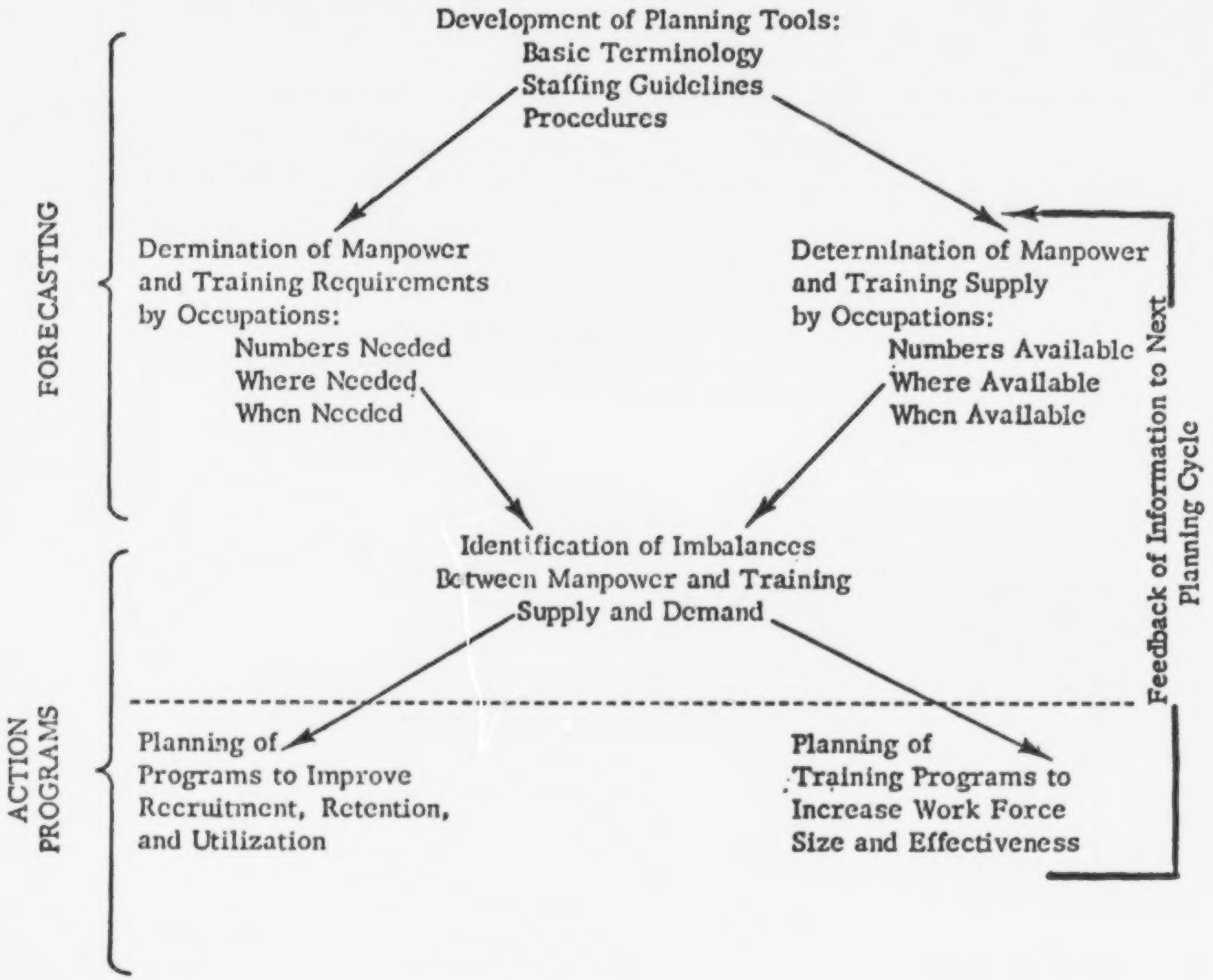
In light of these factors, EPA is developing a manpower planning program to meet the goals of the overall manpower development system. The program has two primary components:

1. Forecasting
2. Action Planning

Exhibit I illustrates the relationships between the various elements of the program. The forecasting component is used to estimate the supply and demand for personnel and the need for additional training. The action planning component identifies opportunities or programs that may be of benefit when it is determined the supply of personnel or training will be insufficient to meet demand. Manpower forecasts are developed by occupation, labor market area and time frame while training forecasts are developed to project entry, update and upgrade training needs.

The planning program is intergovernmental and interagency in nature with the States having an important role. EPA, which initiated the program, is developing the planning tools and providing technical assistance and training to the states and their subdivisions. While the program is not yet operational, field installation has begun. State and local personnel are now being provided with training and technical assistance to build up their capabilities for manpower planning.

EXHIBIT 1
WATER POLLUTION CONTROL MANPOWER DEVELOPMENT PROCESS


Development of Planning Tools:
Basic Terminology
Staffing Guidelines
Procedures
FORECASTING
Dermination of Manpower
and Training Requirements
by Occupations:
Numbers Needed
Where Needed
When Needed
Determination of Manpower
and Training Supply
by Occupations:
Numbers Available
Where Available
When Available
Feedback of Information to Next
Planning Cycle
Identification of Imbalances
Between Manpower and Training
Supply and Demand
ACTION
PROGRAMS
Planning of
Programs to Improve
Recruitment, Retention,
and Utilization
Planning of
Training Programs to
Increase Work Force
Size and Effectiveness

The report includes an interim forecast of water pollution control manpower and training needs through 1976. Despite data limitations which affects the reliability of the projections to some extent, the forecast is indicative of the order of magnitude of the manpower training needs. In summary, this estimate shows the following additional manpower required by 1976:

EXHIBIT 2
ADDITIONAL MANPOWER REQUIRED BY 1976*

Personnel Category \ Sector	Nongovernmental	Local	State	Federal (Non-EPA)	EPA	TOTAL 1976
Professional	10,200	1,300	3,400	1,300	600	16,800
Operator	33,300	8,900	--	1,400	--	43,600
Technician	18,400	1,200	400	200	200	20,400
Other	10,400	11,700	800	400	600	23,900
TOTAL**	72,300	23,100	4,600	3,300	1,400	104,700

The anticipated requirements represent a very rapid growth in the water pollution control work force, as may be seen in Exhibit 3:

EXHIBIT 3
LABOR FORCE GROWTH 1971 to 1976*

Personnel Category	1971 Manpower Engaged	1976 Manpower Requirements	Percentage Increase
Professional	25,400	42,200	66%
Operator	49,300	92,900	88%
Technician	26,900	47,300	77%
Other	47,800	71,800	50%
TOTAL	149,400	258,800	73%

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*The bases for these figures are set forth in Part II-D of this report.

**An undetermined portion of this total will be assigned on a part-time basis to water pollution control activities.

This growth in the work force, according to EPA estimates, will result in a substantial demand for both entry-level and update training. The average annual training requirements are summarized in Exhibit 4.

The five-year total training need is projected to approach 130,000 entry and 380,000 update training actions during the 1971-1976 period.

The largest increase indicated by the forecast is for more operators. The increase projected in the number of waste treatment plants coupled with the increased sophistication of treatment processes are expected to result in an increase in operator training requirements as well. EPA observations and a report by the General Accounting Office (GAO) indicate that the effectiveness and efficiency of existing treatment plants is already impaired by understaffing and undertraining of operators.

With regard to professionals, there will be a need for more highly trained sanitary engineers, primarily because of the increased technological sophistication of the water pollution control process. Further, specialized water pollution control training is necessary in substantial quantity for professionals of other backgrounds entering the field. Also, from Exhibit 4, it is estimated that there will be a substantial demand for update training for all professionals.

The report also notes that there will be an increased demand for technicians with one or two years of college level training and that substantial update training for the present work force will be required.

Manpower Recruitment, Retention, and Utilization

Gross manpower and training requirements can be partially fulfilled through personnel activities designed to:

- Ensure that a sufficient supply of basically qualified persons are available for recruitment;
- Improve retention rates in the existing work force; and
- Improve utilization of the existing work force.

Successful performance of these activities is crucial to achieving the goals of the overall manpower development system. While primary responsibility for recruitment, retention and utilization of water pollution control manpower rests with individual employers, there are certain activities which EPA can undertake in this area for the benefit of all employers of water pollution control personnel. For example, in recruitment, EPA has produced a very successful movie, "Talent Search," in English and Spanish versions. It has also produced recruitment brochures, and provides employment information to servicemen pending discharge, and to veterans. In retention EPA has supported the adoption of meaningful operator certification programs. In utilization EPA has developed guidance on the application of industrial engineering techniques to wastewater processing.

EXHIBIT 4
FORECASTED TRAINING REQUIREMENTS*
(Average Annual Load--1972 - 1976)

Sector / Personnel Category	Nongovernmental		Local		State		Federal Non-EPA		EPA		TOTAL	
	Entry	Update	Entry	Update	Entry	Update	Entry	Update	Entry	Update	Entry	Update
Professional	2,960	9,140	500	2,480	880	1,920	520	2,640	160	1,260	5,020	17,440
Operator	8,260	16,020	3,480	17,080	-	-	520	2,460	-	-	12,260	35,560
Technician	5,160	14,860	480	2,300	100	260	140	960	40	280	5,920	18,660
Other	2,580	3,280	400	1,260	-	-	60	280	180	-	3,220	4,820
TOTAL	18,960	43,300	4,860	23,180	980	2,180	1,240	6,340	380	1,540	26,520	76,480

***The bases for these figures are set forth in Part II-D of this report.**

The subject of operator certification is considered an important part of the recruitment, retention and utilization process. A review of the current situation reveals that 47 States now have certification requirements of some kind, including 31 where certification is mandatory. Further, the standards for certification vary substantially from State to State. Since the quality of operator certification programs has a substantial impact on the efficiency of waste treatment plant operation in the States, EPA believes strongly that States should establish mandatory, uniform certification laws based on national criteria.

To meet this objective, EPA is providing technical and financial support to the Water Pollution Control Federation, the American Waterworks Association, and other interested organizations to establish a national certification board. It is anticipated that this board will serve as an information center for certification activities, recommend standards and guidelines, facilitate reciprocity between State programs and assist authorities establish and upate programs. To facilitate States' adoption of certification programs based on national criteria, technical assistance and training should be provided by EPA.

Manpower Training

A substantial amount of training for the water pollution control labor force is conducted by EPA and by others -- including educational institutions (both four-year colleges and universities and two-year colleges and technical schools), professional and trade associations, private industry, local government agencies, State government agencies, and Federal agencies other than EPA -- for three types of water pollution control manpower[1]: Professionals, Operators and Technicians.

Non-EPA Training Activities

Non-EPA organizations conduct a variety of training: Professional training has been largely restricted to graduate-level entry programs; lower-level operator training has concentrated in centralized locations oriented primarily to the need for larger facilities; and training for technicians and higher level operators which has been sporadic and narrowly focused. A comprehensive strategy to focus programs on particular and comprehensive needs has yet to be developed.

Current efforts are fragmented and lack coordination. As a result, there may be some unnecessary overlapping and some inefficiencies in these programs. Thus, mechanisms for achieving economies through interagency coordination and subsequent channeling of resources to priority needs in water pollution control training would strengthen existing programs.

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[1] While the manpower planning program forecasts needs for a fourth category, Others, these other personnel require little or no specialized water pollution control training and, therefore, are not of concern for a discussion on water pollution control training.

EPA Training Activities

The battery of EPA training programs which is outlined in Exhibit 5 is intended to contribute to fulfilling training needs which are unmet by others. As indicated by the Exhibit, EPA's contribution may be:

- Professional Training Grants for Graduate Programs
- Research Fellowships
- Direct Training
- Technology Transfer
- Operator and Technician Training
- Undergraduate Scholarships

Professional Training Grants

Pursuant to Subsection 5(g)(3)(A) of the Act, EPA awards professional training grants to institutions for the establishment, expansion, and improvement of graduate-level programs in water pollution control. This program is intended to produce a cadre of trained professionals prepared to contribute to water quality management through subsequent positions in teaching, research, consulting, or direct operation in the public or private sectors. Renewable grants are awarded annually for one year at a time as part of a training project of five years duration. Grant funds may be used for student stipends as well as to expand and improve staff, facilities, and equipment. Recent program activities are summarized in Exhibit 6.

The cost per student trained in the Professional Grants Program has decreased sharply, reflecting a payoff in earlier investment in equipment and staff. It now costs approximately 50 per cent of what it did in the early 1960's to train a water quality professional under this program. Further, less than 3 per cent of the manpower trained under the grants program has left the water quality field.

Research Fellowships

Pursuant to Subsection 5(g)(3)(B) of the Act, EPA awards fellowships to graduate students for selected specialized research training in water pollution control. The purpose of this program is to increase the number and competence of engineers and scientists qualified to conduct independent research and advanced practice in conjunction with teaching at the graduate level. Awards are made on a competitive basis primarily to Doctoral candidates in engineering, physical sciences, biological sciences, or socioeconomic disciplines. Recent activities under this program are summarized in Exhibit 7.

EXHIBIT 5
SUMMARY OF EPA TRAINING PROGRAMS

Program	EPA Authority	EPA Contribution
Professional Training Grants	Subsection 5(g)(3)(A) of the Federal Water Pollution Control Act	Financial support to educational institutions for graduate-level programs in water pollution control.
Research Fellowship	Subsection 5(g)(3)(B) of the Federal Water Pollution Control Act	Awards to graduate students for specialized research training in water pollution control.
Direct Technical Training	Subsection 5(g)(3)(C) of the Federal Water Pollution Control Act	Direct training and training support for others in technical matters relating to the causes, prevention, and control of water pollution.
Technology Transfer	Subsection 5(g)(3)(C) of the Federal Water Pollution Control Act	Direct training to practicing professionals, public decision-makers, conservation groups, and the general public.
MDTA		
Coupled OJT	Agent for the Departments of Labor (DOL) and Health, Education, and Welfare (DHEW) under the Manpower Development and Training Act (MDTA)	Program administration for entry-level operator training.
Institutional Training		
Public Service Careers	Agent for DOL under MDTA.	Program administration for entry-level operator training.
Transition	Agent for DHEW and the Department of Defense.	Program administration for entry-level operator training.
Pilot Program	Subsection 5(g)(1) of the Federal Water Pollution Control Act	Direct training, financial support, and training support for update and upgrade operator training.
Undergraduate Training Grants	Section 16 of the Federal Water Pollution Control Act	Financial support to undergraduate institutions to conduct programs in water pollution control; facilities design and facilities operation and maintenance.
Undergraduate Scholarships	Section 18 of the Federal Water Pollution Control Act	Awards to undergraduate students for study leading to careers in the operation and maintenance of wastewater treatment facilities.

EXHIBIT 6
PROFESSIONAL TRAINING GRANTS PROGRAM ACTIVITIES 1970-1972

	ACADEMIC YEAR	
	1970-1971	1971-1972
Number of Traineeships Authorized *	788	932
Number of Trainees Appointed *	1,028	1,051 **
Number of Professional Training Grants	88	91
Number of States Involved	43	43
Number of Institutions Involved	72	82
Amounts Awarded	$3,781,756	$4,562,682

*"Number of Traineeships Authorized" refers to the number of traineeships slots authorized. Since more than one trainee may occupy the same slot in a given year due to turnover, the "Number of Trainees Appointed" logically exceeds the number of slots authorized.

**Estimate

TRAINING DISCIPLINES--1971-1972

Under these grants, training was provided in the following disciplines:

- Environmental Engineering
- Sanitary Engineering
- Environmental Chemical Engineering
- Environmental Systems Engineering
- Agricultural and Environmental Engineering
- Environmental Mining Engineering
- Nuclear Environmental Engineering
- Soils Environmental Engineering
- Environmental Biology
- Limnology and Aquatic Biology
- Estuarine Biological, Physical and Chemical Oceanology
- Water Chemistry
- Interdisciplinary Environmental Programs
- Environmental Economics

EXHIBIT 7

RESEARCH FELLOWSHIP PROGRAM ACTIVITIES 1970-1972

	ACADEMIC YEAR	
	1970-1971	1971-1972
New Research Fellowships Authorized*	60	46
Total Research Fellowships Awarded*	105	108
Number of Active Fellows*	149	161
Number of States Involved	29	27
Number of Institutions Involved	51	58
Funds Awarded	$600,000	$600,000

*"New Research Fellowships Authorized" refers to the number of new fellowships awarded in the year. "Total Research Fellowships Awarded" refers to the sum of new fellowships awarded in the year and pre-existing fellowships renewed during the year. "Number of Active Fellows" refers to the total number of active fellows during the year; this figure is derived by adding the "Total Research Fellowships Awarded" for the year to the number of fellows continuing under fellowships awarded in the previous year.

This program has proven to be the primary source of instructors for university training of professionals and the primary mechanism for building professional research capacity. Over 70 per cent of the research fellows normally go into teaching or research.

Direct Training

Under Subsection 5(g)(3)(C) of the Act, EPA conducts a program of direct technical training in water pollution control matters and provides technical assistance to others similarly engaged. The purpose of this program is:

- To provide a continuing, comprehensive program of specialized and advanced technical training generally unavailable elsewhere.
- To research and develop instructional technology, and to provide an instructor development program for individuals responsible for and/or conducting environment training or related activities.
- To provide, on request, instructors and/or training materials in support of the training programs of other Federal, State and local agencies.

Students are drawn from the staffs of many water pollution control employers, usually for short courses--two weeks or less--conducted in EPA facilities by specialists from the EPA staff. Normally courses are oriented to professionals, although they are also available to other personnel categories.

The courses given provide either overview summaries of the concepts, science, and techniques for abating and preventing pollution, or detailed reviews of new technological developments, operational methods, and research findings. They also address specific practical features of wastewater treatment design and operation, water quality evaluation in field and laboratory, and technical and administrative aspects of water quality management and water pollution control.

In the FY 1972 program, EPA plans to improve delivery of direct technical training courses by:

(i) Provision of learner-centered instruction.

(ii) Formation of mobile training teams to provide courses to small isolated plants.

(iii) Initiation of correspondence courses.

The following table summarizes recent program experience:

Year	Courses	Students
1969	45	1,297
1970	57	1,560
1971	59	1,630

These students came from at least 14 different occupational groups.

Technology Transfer

The Technology Transfer Program is new and is intended to speed the utilization of new technology in the water pollution control field. To date, the program has concentrated on technology transfer primarily in municipal pollution control. The target groups for the program listed in order of priority are:

(i) Design engineers.

(ii) Public decision makers.

(iii) Conservation groups and the general public.

Training is of both "general awareness" and "detailed knowledge" types. Since the program was first initiated in 1971, specific activities to date have been limited. They include:

-- Presentation of two-day technical workshop/seminar programs for engineers designing wastewater treatment facilities.

-- Developing design manuals for consulting engineers

-- Monitoring 60 demonstration grant projects

-- Developing visual presentations

Preliminary assessments of this program are favorable. The seminars were well received, and a heavy volume of correspondence was generated from public and private engineers involved in the design process.

Operator and Technician Training

EPA has also been active in training for water pollution control jobs below the professional level. This has been done first, as a program manager for the Department of Labor, Health, Education and Welfare, and the Department of Defense under training activities conducted pursuant to the Manpower Development and Training Act (MDTA). Second, it has been done under Subsection 5(g)(1) and Sections 16 of the Act.

As program manager under MDTA, EPA has operated four types of entry-level and/or upgrade operator training programs:

(i) Coupled OJT

(ii) Institutional training

(iii) Public Service Careers

(iv) Transition training

Training is conducted through subcontracts from EPA to units of State governments, municipalities, special wastewater treatment districts, vocational schools, community colleges, and universities. Additionally, EPA works with State and local agencies to help them qualify for MDTA support, arranges training for instructors, provides teaching materials and curriculum development assistance, and otherwise assists State and local governments in getting training projects under way.

The programs, which are now continuing, have already enrolled between 3,500 and 4,000 trainees, most of whom qualify as disadvantaged. Graduation rates have been high, as has been the rate of successful employment.

These programs have been highly successful in meeting needs for more skilled operators. In addition, they have proven that trainee operators could be drawn from the disadvantaged--the unemployed, the underemployed, and the minority groups--and be successfully trained for a variety of water pollution control jobs. It has also shown that the career ladder concept can be highly effective in improving public service in this field. However, serving as program manager has resulted in certain problems for EPA:

(i) It has been necessary to convince potential sponsors, e.g., municipalities, that the program can take disadvantaged persons and train them adequately to perform effectively over an extended period.

(ii) It has been necessary for EPA to locate adequate facilities and train instructors for the programs because of the absence of an instructional framework.

(iii) It has been necessary to convince sponsor agencies, which are only secondarily concerned with fulfillment of the goals of the Federal Water Pollution Control Program, of the continued high priority of these programs. Sponsor agencies are orientated to counterpart State agencies rather than to pollution control agencies and their specific needs and requirements.

Generally, although not completely, the first two problems have been overcome; the thrid has not. To obtain funding at expanded levels to meet the requirements projected over the next five years, a new mechanism is needed. One such approach would draw EPA, DOL, and DHEW together to coordinate the use of MDTA-type funds committed to water pollution control training.

To date, subsection 5 (g)(1) of the Act, which authorizes a pilot program for supplemental manpower development and training programs for persons entering into operations and maintenance of treatment work and related activities, has been used in small part to provide advanced instructor training for instructors serving in the MDTA program. More importantly, it has been used to develop specialized training courses in advanced wastewater treatment. (The MDTA courses focus on entry- and low-level upgrade training.) The bulk of the FY 1971 pilot program was used to fund grants for 24 grants to States (and one Region). The grants were made in response to applications for innovative plans representing compelling needs from the recipients. Twenty-two grants were awarded for training and two for curricula and materials developed, to 20 different jurisdictions. FY 1971 training under 5(g)(1) is summarized below:

Program	Total Number of Trainees	Total Amount of Grant
Advanced Instructor Training	50	$ 39,174
Specialized Training in Wastewater Treatment	190	183,114
Grants for Special State Projects	2,945	734,416
	3,185	$ 956,704

It is too early to evaluate the pilot program. However, enrollment request far exceed capacity under present funding levels. The pilot projects presently supported represent only a small portion of the needs critical by the States.

The pilot program to date has:

- Established a mechanism to immediately initiate the training necessitated by an accelerated program
- Provided an initial framework upon which the States can build and for which they can eventually assume responsibility.

The last of the EPA training programs are those funded under Sections 16 and 18 of the Act. These provide grants and scholarships at the undergraduate level for training of higher level operators, technicians, and pre-baccalaureate engineers. Thus far, Section 16 training has been used primarily for training of qualified high school graduates in junior colleges in the operation and maintenance of waste treatment plants and related facilities. This training is intended to fill the gap between lower level operator training and four- or five-year professional training, particularly at the technician and senior operator levels. Under this program, training grants have been awarded to technical schools, junior colleges, and similar institutions to develop and test new approaches to curricula development. Only one grant has been directed toward bachelor degree training in design, as the need for operations and maintenance training resulting in an Associate degree was deemed much more critical.

The entire FY 1971 appropriation of $331,000 was used to award grants to seven institutions for planning and design of curriculum material, for initiating training programs, and for materials development.

Meaningful assessment of the Section 16 program is precluded by its newness. However, the grantees have made good progress, and the initial training courses were initiated at the beginning of the 1971-1972 academic year.

As the role and strategy of EPA at the national level require strengthening, so do the roles and strategies of the State water pollution control agencies. Much of EPA's training strategy depends on the assumption of greater and, indeed, parallel responsibilities at the State level. The capacities of State agencies to do so are limited and require immediate attention. They must be strengthened to assume greater leadership, and coordinative roles and programs must be tailored to the institutional arrangements peculiar to individual States.

PART I
INTRODUCTION

The Environmental Protection Agency (EPA) is responsible for the execution of the Federal Water Pollution Control program. The overall program goal is expressed quite simply by the symbol:

CLEAN
WATER

This program is to be accomplished through a Federal partnership with the States and their subdivisions, with the Federal Government assuming its full responsibility while giving the first opportunity to manage and solve the problems to the States and local governments. More specifically, the goals of the program for the 1970's are:

(i) Acceleration of the program for construction of treatment facilities.

(ii) Improved standards and enforcement.

(iii) Improved assistance to the states.

(iv) Better programs for prevention and abatement of pollution from Federal facilities.

(v) Development of programs to deal with emerging problems.

Achievement of these goals requires the people of the United States, acting both privately and publicly at all levels of government, to apply adequate resources--men, material, and money--to do the job.

This report focuses on men--the manpower needed to produce clean water. This includes the manpower necessary to authorize the commitment of resources; to set and enforce standards; to plan the details of the programs; to develop, design, construct, operate, and maintain facilities; and to provide administrative support for these operations. The report examines manpower and training needs, both present and projected, and discusses activities that have been taken to meet these needs. Its emphasis is, of course, on the planning and training that has been accomplished under subsection 5(g) of the Federal Water Pollution Control Act. Further, it attempts to present a comprehensive analysis of the water pollution control manpower situation by discussing all its aspects.

Preliminarily, it should be noted that recently substantial attention has been centered on the quantity and quality of manpower operating waste treatment plants. Observations of EPA indicate that undermanned plants and underqualified personnel are too frequently causing plants to operate well under design standards. A 1970 study by the General Accounting Office (GAO) bears out these observations. In its report to Congress on a survey of 69 municipal wastewater treatment facilities, GAO noted that 59 of these plants did not fully meet the minimum provisions for personnel, laboratory controls, or records recommended by the 1963 Conference of Sanitary Engineers; of 12 that appeared to have serious operation and maintenance problems, seven needed additional qualified plant-operating personnel.[1] The report concluded:

> A frequent cause of O&M [Operations and Maintenance] problems at waste treatment plants is the lack of a sufficient number of qualified personnel to operate the facilities. Waste treatment plants must be staffed with an adequate number of qualified personnel to achieve the designed level of treatment and maintain and protect the community's investment in the physical plant. Deficiencies in either the quantity or qualifications of the operating staff can adversely affect a plant's operation.[2]

The GAO indicated that its conclusion was based on reports from knowledgeable individuals in the Federal Water Quality Administration (EPA's predecessor organization), State water quality offices, municipal wastewater treatment facilities, and consulting engineering firms that a lack of qualified operators was a principal cause of plant operation and maintenance problems.

Further, as reported below, there are substantial manpower and training needs for other classes of manpower as well. These can cause reduced effectiveness and efficiency in water pollution control.

The reasons for such problems are several--including failure to anticipate manpower needs; handicaps to recruitment and retention because of inadequate budgets, low salaries, or lack of advancement opportunities; poor utilization of manpower; and the failure to properly train employees in job skills. These reasons appear without any necessary relation to the classification of the employees, the type of employer, or the labor market area. However, they all do relate to manpower management functions. In this respect, overcoming the problems and developing a qualified and motivated work force requires a comprehensive manpower program.

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[1] Comptroller General of the United States, Report to Congress: Need for Improved Operation and Maintenance of Municipal Waste Treatment Plants--Federal Water Quality Administration, Department of the Interior B-166506, 1 September 1970, p. 18.

[2] Ibid, p. 21.

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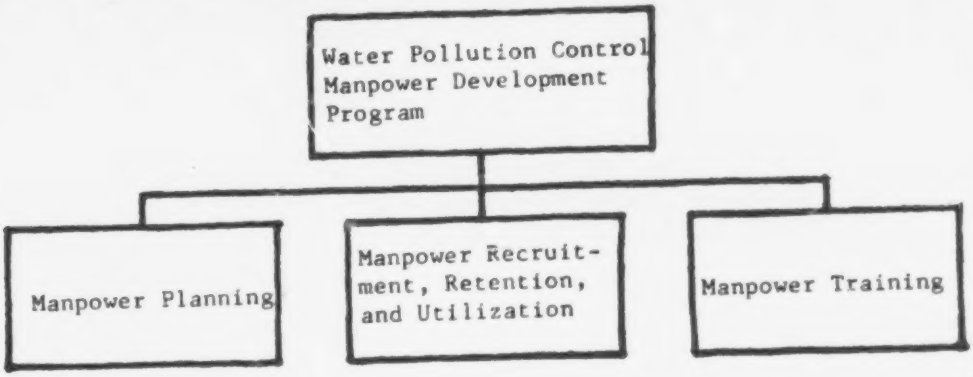
In this vein, EPA has conceived of a manpower development program[1] to ensure fulfillment of water pollution control manpower needs through three interdependent functional units, as follows:


Water Pollution Control Manpower Development Program
Manpower Planning
Manpower Recruitment, Retention, and Utilization
Manpower Training

Each unit is concerned with all manpower classes, types of employers, and labor market locations as they relate to the unit management function.

The manpower development program includes both public and private organizations. The public organizations include Federal, State, and local governments. Within each level, government involvement includes agencies that use water pollution control manpower as well as those that provide training. This is also true on the private side, the program including educational organizations as well as product-oriented organizations. Thus, the program operates within the general manpower development framework of the country.

The manpower development program concept provides the basis for the organization of this report. Thus, Part II reports on the manpower planning program, including the forecasting component authorized by subsection 5(g)(2) of the Federal Water Pollution Control Act, and offers interim estimates of manpower and training needs. Part III is addressed to the recruitment, retention, and manpower utilization activities undertaken by EPA. Part IV discusses manpower training activities, including those authorized under subsection 5(g)(1) and 5(g)(3). A summary is presented in Part V of this report.

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[1] The program is administered by the Manpower and Training Division of the Office of Water Programs of EPA.

PART II
THE WATER POLLUTION CONTROL MANPOWER PLANNING PROGRAM

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PART II
THE WATER POLLUTION CONTROL MANPOWER PLANNING PROGRAM

A. Introduction

If the national goals for water pollution control are to be met, manpower to operate the national water pollution control system must be available in needed amounts, with the requisite skills, at the proper times, and in the proper places. The manpower must also be properly utilized by management, and the employees must be personally satisfied with their situations. The difficulties in meeting this requirement become manifest when the combined effects of the following factors are considered:

- The current large number of jobs (1971 estimate--149,400).
- The projected rapid growth in jobs (1976 estimate--254,200).
- The large number of employers (1971 estimate--25,000, public and private).
- The geographic diffusion of jobs throughout the nation.
- The large number of different occupational categories that constitute the universe of water pollution control jobs (EPA has identified 144 different occupations).
- The changing technology that affects the nature of the work performed by many employees.

These factors indicate the urgency for careful planning if current and future manpower requirements are to be fulfilled. Clearly, an effective water pollution control manpower planning program of substantial nature is required to serve as a rational base for action programs.

The Congress, in subsection 5(g)(2) of the Federal Water Pollution Control Act, authorized EPA to develop and maintain a forecasting program and to publish the results of forecasts produced by the program. In accordance with this statutory requirement EPA has been working to create a comprehensive program which combines a manpower forecasting activity with the planning of action programs.

Section B of this part of the report sets forth a description of the forecasting program and a status report on its implementation and discusses action planning activities which complement and follow up on manpower forecasts. Section C, below, describes the universe of water pollution control manpower as a basis for the interim manpower and training forecasts (Section D) which have been specially developed to serve while implementation of the manpower planning program is completed.

B. The Manpower Planning System

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EPA is presently developing forecasting and action planning on a nationwide basis for the major categories of water pollution control manpower. Forecasting must be by occupation since training requirements vary tremendously by occupation and thus cannot be usefully forecast without an occupational relationship. The program will involve the accumulation and reporting of compatible data for each occupation on a local, State, and national basis so that planning will be possible on all of these levels.

A key premise of the program is that it depends upon information from all levels of government and all types of commercial organizations. A second key premise is that planning for water pollution control manpower cannot be conducted independently of planning for other career fields since it draws from the same manpower pool and has objectives overlapping with other manpower planning programs.

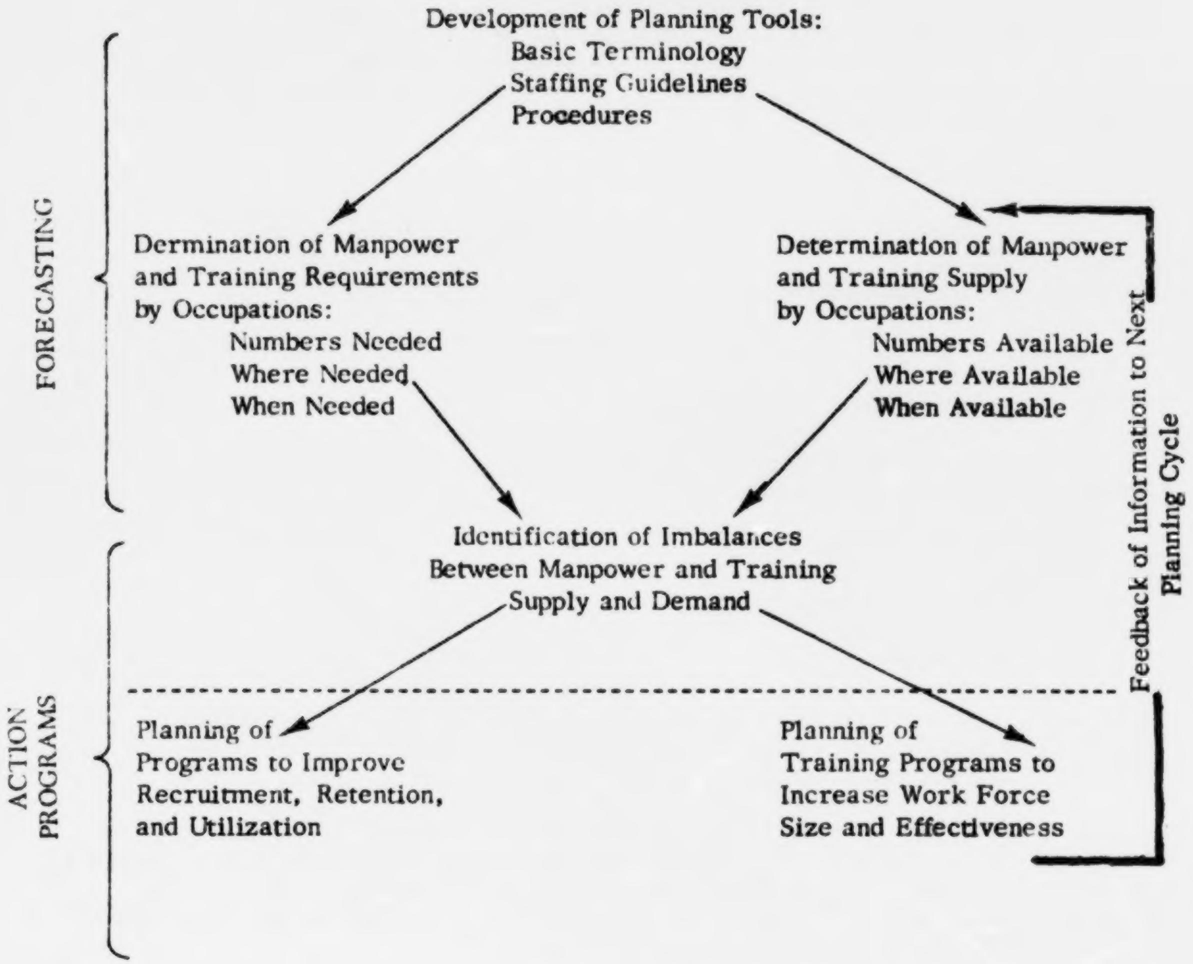
In this respect, EPA supports the Cooperative Area Manpower Planning Systems (CAMPS) mechanism. Utilizing broad Federal planning guidelines, under CAMPS, it is intended that the states and their local areas forecast manpower requirements for numerous career fields and draw up action plans to meet many of these needs. CAMPS was initiated in 1967 by the Department of Labor in order to achieve cooperation and coordination in planning for all fields of manpower. At this point in time, the CAMPS mechanism is primarily concerned with training the disadvantaged. Capabilities have not yet been established to deal in depth with the complexities of manpower planning for the water pollution control manpower program. Within the CAMPS mechanism, local coordinating committees meet regularly to determine overall manpower and training needs for their areas, including any identified in the water pollution field and to outline a series of training courses. These determinations are expressed in an annual comprehensive manpower and training plan for the area. State coordinating committees work out conflicts between local plans and combine local plans to form a blueprint for the state. Federal regional committees review and approve the state plans, and at the national level, a coordinating committee representing six Federal departments and three agencies, including EPA, sets national goals as a framework within which local and State committees prepare their annual plans.

In addition to maintaining a planning relationship with other agencies of the Federal government through its membership in the CAMPS national coordination committee, EPA endeavors to coordinate with and provide assistance to other Federal agencies having planning interests that affect or require water pollution control manpower. Illustrative of this is the technical assistance being provided by EPA to the Bureau of Labor Statistics on a project sponsored by the National Science Foundation to determine the impact of new national programs on employment. Initial efforts of this project focus on the national water pollution control program. Through the use of an input-output simulation model, the impact of Federal expenditures for water pollution control will be traced through the involved public and private organizations. As part of this study, BLS and EPA will utilize computer processes to jointly calculate total employment by occupation that is produced by various levels and types of expenditures for water pollution control. This study is expected to be completed late in 1972.

Another example of coordination is the joint EPA/DOL survey of municipal wastewater treatment plants which is described in subsection B-2-b, below. Unfortunately, adequate coordination has not yet been completely established with other Federal agencies--such as the Department of Housing and Urban Development, the Census Bureau, the Civil Service Commission, and the Office of Education (Department of Health, Education, and Welfare)--whose programs include water pollution control manpower planning aspects.

As shown in Exhibit II-1, the EPA manpower development process is a continuing one; manpower forecasts provide the basis for development of action plans, and the information generated by the completion of action planning (and subsequently action plan implementation) is fed back as data for the next planning cycle. The purpose and scope of these two components of the water pollution control manpower planning process are discussed below, together with the activities conducted to implement both aspects of the program.

EXHIBIT II-1
WATER POLLUTION CONTROL MANPOWER DEVELOPMENT PROCESS


Development of Planning Tools:
Basic Terminology
Staffing Guidelines
Procedures
FORECASTING
Dermination of Manpower and Training Requirements by Occupations:
Numbers Needed
Where Needed
When Needed
Determination of Manpower and Training Supply by Occupations:
Numbers Available
Where Available
When Available
Identification of Imbalances Between Manpower and Training Supply and Demand
ACTION PROGRAMS
Planning of Programs to Improve Recruitment, Retention, and Utilization
Planning of Training Programs to Increase Work Force Size and Effectiveness
Feedback of Information to Next Planning Cycle

1. The Forecasting Component

The broad purpose of the manpower and training forecasting component of the planning process is to provide time-phased information about anticipated needs for water pollution control manpower and training so that actions can be planned and implemented early enough to ensure that the necessary trained manpower is available at the time and places required.

a. The Forecasting Process. Fundamentally, the forecasting process is a comparison of probable manpower demand and supply to identify probable imbalances. Perhaps the best way to describe the forecasting component is through examination of its operational process. As may be seen by an examination of Exhibit II-1, the forecasting process consists of four discrete elements:

- Development of planning tools.
- Determination of manpower and training requirements.
- Determination of manpower and training supply.
- Identification of imbalances between supply and demand.

Each of these activities is described below.

(1) Development of Planning Tools. Fundamental to the forecasting process are three planning tools:

--Basic Terminology.

--Staffing Guidelines.

--Procedures.

These tools must be available before forecasting can actually commence and, therefore, the first task in the forecasting program is their development, as discussed below.

Basic Terminology. The creation and dissemination of standard terminology based on generally understood and accepted word or phrase meanings substantially reduces the probability of misunderstandings. Accordingly, an early step in the creation of the forecasting component is the development of a tool that may be called a "program language."

Critical terms for definition in the forecasting component are the basic structural categories of the planning system, the various occupations. For example, the label "operator" has historically been applied to a variety of job descriptions. If the forecasts are to be reasonably accurate, the term "operator" must mean literally the same thing to persons who identify, aggregate, and analyze needs; otherwise findings will

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be distorted and invite an erroneous action. To provide for such common understanding, the occupational definition will convey a body of information, including:

(i) A statement of the tasks ordinarily performed by personnel in the category.

(ii) A statement of qualifications for inclusion in the category in terms of the general and vocational education, aptitudes, and physical qualities necessary.

Because it is most economical to have only one effort to develop the required terminology, it is appropriate that the terms be defined at the Federal level and then distributed to all other levels. Therefore, EPA has the responsibility for developing, disseminating, and subsequently maintaining definitions. Basically, this is done by studying the tasks performed by a sample of water pollution control employees and then constructing the definition around work tasks commonly grouped into similar jobs, as revealed by industry practice. The structure of the definitions follows that of the Department of Labor's Dictionary of Occupational Titles in that occupations are classified by job family and industrial category and are described by tasks performed, requisite training, and aptitudes and physical qualities required to perform the occupation.

Staffing Guidelines. As has been seen, the forecasting component requires need identification by many different people. In determining the needs, judgments are necessary; for example, does it require seven or 17 operators (as defined) to operate a given plant? Although raw judgments in reasonably similar situations may vary substantially from individual to individual, the result of untempered judgment on forecast input data could be outputs with unacceptable margins of error, particularly at the local level where varying judgments would ordinarily have little opportunity to offset each other.

To control this possibility, managers have developed the technique of supplying guidelines to those making needs judgments. Commonly, these guidelines relate staffing needs to ranges of units of production for given facility arrangements. Thus, in the case of water pollution control, for example, staffing needs of treatment plants can be generally related to plant capacity and type in terms of the number of millions of gallons of waste per day that a particular type of plant is designed to treat. A possible staffing for a primary treatment (sludge digestion, sludge beds or lagoon) plant is shown in Exhibit II-2.

Thus another necessary tool for operation of the forecasting component is staffing guidelines. They are appropriately developed at the Federal level since it would be uneconomical to undertake a number of separate efforts to produce them. The responsiblity for development is on EPA. The staffing guides are developed on the basis of studies of standard practices in different types of production units throughout the industry.

EXHIBIT II-2
SAMPLE STAFFING GUIDE FOR WASTEWATER TREATMENT PLANT

Type: Primary Treatment
Sludge Digestion; Sludge Beds or Lagoons

	Plant Average Day Capacity, mgd									
OCCUPATION TITLE	1	3	5	10	20	35	50	65	80	100
Superintendent		.5	.5	1	1	1	1	1	1	1
Assistant Superintendent						1	1	1	1	1
Clerk Typist					1	1	1	1	2	2
Operations Supervisor										1
Shift Foreman										2
Operator II	1	1	2	2	3	5	5	6	7	7
Operator I	3	3	3	3	4	5	6	6	7	8
Auto. Equipment Operator								1	1	1
Maintenance Supervisor								1	1	1
Mech. Maintenance Foreman							1	1	1	3
Mechanic II				1	1	1	1	2	2	2
Mechanic I					1	1	1	1	2	2
Electrician II					.5	1	1	1	1	2
Electrician I							1	1	1	1
Maintenance Helper					1	1	2	2	3	4
Laborer	.5	2	2	2	2	3	5	5	6	7
Painter										.5
Storekeeper								1	1	1
Custodian							1	1	1	1
Chemist										.5
Laboratory Technician				1	1	2	2	2	2	2
Total Staff	4.5	6.5	7.5	10	15.5	22	29	34	40	50

Note: Plant components included in this example:

Liquid Treatment
Raw wastewater pumping
Preliminary treatment
Primary sedimentation
Chlorination

Sludge Treatment
Primary sludge pumping
Sludge digestion
Sludge drying beds
(1, 3, 5 mgd plants)*
Sludge lagoons
(10 mgd and larger plants)*

Other Plant Components
Yardwork
Laboratory
Administration and general

*Sludge removed and hauled from plant site by staff personnel.

Procedures. The third tool required in a forecasting process involving far-flung multiple data inputs and analyses is a set of procedures. Again, the objective is to reduce forecasting error by tempering the individual judgments that otherwise would be made independently and, probably, inconsistently. A second objective is to reduce the man-time required for operation of the forecasting component by the development of one system for all to follow rather than having each contributor take the time to develop his own procedures. The third objective of the development of standard procedures is to ensure that data are collected in a format that will be accepted by EPA's national computerized system for the storage and retrieval of water quality related data (STORET).

Procedures for use throughout the length and breadth of the forecasting process are most economically developed by the entity having the overview of the entire system, the Federal Government. Accordingly, this responsibility is given to EPA. The procedures are created by fusing the knowledge of planning specialists with that of manpower and training specialists.

(2) Determination of Manpower and Training Requirements. In order to identify the demand for water pollution control personnel, it is planned to employ the following process. Manpower and training requirements which constitute demand, form one leg of the forecasting process. All Water pollution control employers,[1] using the planning tools described above, will determine their employee needs in terms of net additions to their respective work forces by occupation (as defined in the tool-making process) for each year in the planning spectrum. This is to be done by comparing the present work force, by occupation (after adjustment for attrition and upgrade potential), with that anticipated in each of the planning years and reporting the difference. To determine the anticipated work force, the employer must first identify the expected work load by function in each planning year. Fortunately, many water pollution control employees can do this with a high level of confidence because generally major changes in work load are associated with major capital improvements whose activation dates can be predicted fairly accurately several years in advance. Having anticipated the work load by function, the employer can use experience and/or standard guidelines to anticipate accurately needed staff additions.

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[1] The forecasting program is designed to include the needs of both public and private employers. To the extent that employers do not participate in the program, demand will be understated.

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Next, employers determine their training needs by occupation, by numbers requiring training, and by time frame. Three types of training needs are identified:

(i) Entry Training--The specialized vocational training that is required for occupational proficiency upon initial entry into a career field. This training may be received before or immediately after initial employment in the career field.

(ii) Upgrade Training--The training that current employees will need in order to become proficient in a new occupation, usually in the same career field. This training is undertaken as a result of or pending promotion.

(iii) Update Training--The training that current employees need to maintain proficiency in their current occupations because of technological or other changes in their jobs; in cases where employees are currently performing below the established proficiency level, this includes the training necessary to bring them to proficiency.

Entry training will be largely determined by anticipated new hires, upgrade by anticipated promotions, and update training by management judgment based on performance reviews and anticipated changes in the work environment.

Technical assistance for employers needing it to produce the training needs data required by the program will usually be provided by local or State employees who are specialists in training related to water pollution control.

The manpower and training needs of employers are then reviewed, adjusted as appropriate, and aggregated by occupation and year needed, initially for each labor market area, then for each State, and finally, on a nationwide basis. The initial review, adjustment, and aggregation will ordinarily be accomplished by local planning and training specialists, who are best acquainted with the local peculiarities which must be taken into account. However, in some cases local planners and trainers will not be available, and the initial aggregation will be done by State staff. In other cases local staff may be available but not fully capable. In this situation, the State water pollution control staff will ordinarily provide technical assistance and/or training to the local staff. Assignment of these functions to the states is a primary reason why the states are considered the keystones of the forecasting program. The State/local interface in this respect ordinarily will be closely related to State review of applications for capital grants and to State monitoring of operations in grant-in-aid facilities.

State review, adjustment and aggregation is to be accomplished by the State staff specialists in water pollution control planning and training, who will be able to bring a state-wide view and a very high level of expertise to the demand determination. This again suggests the key role of the states in the process. It also suggests that the program will flounder without properly qualified personnel in the State manpower planning and training staff. An important aspect of the program then is technical assistance and training to the State personnel to ensure the level of performance required for program success. The Federal Government, through EPA, is assigned the responsibility of providing this technical assistance and training.

The final review, adjustment, and aggregation will provide a national picture of demand. To be developed by EPA, this calculation will offer the opportunity for adjustments based on a national view, such as anticipated changes in national economic or environmental policies or adjustments for interstate overlaps in the labor market.

(3) Determination of Manpower and Training Supply. The second leg of the forecasting program is determination of manpower and training supply. The supply determination process runs concurrently with demand determination. Many of the same individuals and institutions will be as deeply involved in shaping the supply leg as the demand leg, but there are some differences in approach.

To determine the manpower supply is to determine the anticipated numbers of available manpower by occupation, labor market area, and planning year. Included in supply are:

(i) The anticipated training program graduates ready to begin employment in the occupation.

(ii) The anticipated unemployed who have had entry training or equivalent experience in the occupation.

The determination of the former requires an estimate of anticipated entry training programs by occupation, number of training slots, labor market area, and planning year. This information will be collected from employers at the same time demand information is collected. It must also be collected from other organizations that deliver entry training. It is planned that this information will be aggregated at the labor market area,[1] State, and Federal levels, with the respective staff specialists having responsibilities similar to those they hold for demand determination.

Determination of the anticipated unemployment of entry-trained personnel is a matter for the judgment of labor market specialists and labor economists; their judgments are to be aggregated with the entry-training output supply.

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[1] A complication that develops here is that entry training, particularly professional training, occurs to some extent in locations unrelated to the local or State labor market. This will be taken into account in the adjustment that accompanies aggregation.

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(4) Identification of Imbalances Between Manpower and Training Supply and Demand. The purpose of the forecasting component is to provide estimates of manpower and training needs. In this step, the supply and demand data are analyzed in their entirety, imbalances are identified, and the estimates of needs are derived.

Analysis is to be conducted on the local, State, and Federal data aggregations. Normally, local planning staffs will compare the demand and supply figures, make adjustments as necessary, and develop forecasts for their respective labor markets. The State water pollution control agency staffs will make comparable analyses and forecasts for the states, and the EPA staff will make the national analysis and forecast. Technical assistance and training will be provided as needed in analysis, as it is in the demand and supply determination stages.

The manpower forecasts will be in terms of additional numbers of employees needed, by occupations, labor market, and planning year. The training forecast, in similar format, will indicate the additional entry training needed to provide the needed additional employees.

b. Forecasting Program Implementation. Authorization by subsection 5(g)(2) of the Federal Water Pollution Control Act, as amended, for the establishment and maintenance of a manpower forecasting system resulted in acceleration of previous efforts in this direction. A small staff has been established at EPA Headquarters. Budget requests for FY 1972 provide for expansion of this staff and establishment of forecasting capabilities in the EPA regional offices. The actions taken to date, in addition to the efforts required for conceptualization of the planning program, are described below.

(1) Accomplishments in the Development of Planning Tools

Conventional Treatment Plants. A contract has been let to provide for the development of occupational definitions and staffing guides for conventional waste treatment plants.

The occupational definitions are following the format of the Department of Labor's Dictionary of Occupational Titles. The occupational definitions will describe for each occupation category the duties performed and the job qualifications in terms of general education, specific vocational training, aptitudes and physical requirements.

The staffing guides will provide, for different types and sizes of waste treatment plants, the number of employees in each occupational category that are normally required for proper operation and maintenance. These guides are not intended to be precise standards; rather, they can be used by design engineers, manpower planners, and others as a frame of reference for planning the staffing of new plants and evaluating the staffing patterns of existing plants.

Similar definitions and guides have been developed for waste treatment plants used in the inorganic chemical industry. This was done as part of a research and development study on the technology and economic aspects of water pollution control by this industry. A study of this type is now also being conducted for the beverage industry.

New Water Quality Pollution Control Systems. Manpower and training requirements are directly related to the work to be done, which, in turn, is in large part a function of the systems employed by water pollution control activities. Therefore, the development of the required occupational definitions and staffing guidelines can be done in coordination with the design of new systems. At the same time, systems designers must take into consideration the cost and availability of operational manpower when considering various alternatives.

To ensure that appropriate manpower information is generated and that human factors are considered in the systems designs, a policy directive and guidance manual are being developed. The manual will specify the types of manpower and training information that should be produced during the design of new systems and will also provide guidance concerning the human engineering techniques that can be employed during systems design.

Through this mechanism, occupation definitions, staffing guides, manpower projections, and training materials can be developed simultaneously with the development of advanced waste treatment processes and other technological advances. The availability of this information will enable the timely development of the manpower required to permit full utilization of the new hardware and facilities.

(2) Accomplishments in the Determination of Manpower and Training Supply and Demand

Joint EPA/DOL Survey of Municipal Wastewater Treatment Plants. A survey to determine the numbers and types of workers required to operate and maintain the nation's existing and planned wastewater treatment plants was started in June 1971. The survey is a joint effort of the Department of Labor's Manpower Administration, the Environmental Protection Agency's Office of Water Programs, and the counterpart State and local employment service and water pollution control agencies.

Over 3,000 plants and municipalities have been contacted to obtain data on current employment, job vacancies, future manpower requirements, labor turnover, and wages. The survey data are now being tabulated by many State agencies, and a national tabulation and analysis has been initiated at the Federal level. The resulting State and national reports should be available by mid-1972.

The survey results can be used by water quality, education, and employment service agencies at all levels of government to plan, budget, and conduct manpower and training programs which will ensure proper staffing of wastewater treatment plants by qualified superintendents, operators, laboratory technicians, maintenance craftsmen, and other workers. The collected data will also provide the basis for the creation of a manpower information system, which is described below. The survey, to date, has been hampered by the limited manpower resources available to some State water quality agencies for this effort. However, the effort has fostered the development of working relationships at the Federal, State, and local levels among environmental and employment security agency staffs; and it can be considered a fundamental establishment of coordinated manpower planning capabilities in these agencies.

The results of this survey will be used as a basis for a manpower information system that is being designed into EPA's national computerized system for the storage and retrieval of water quality related data (STORET). It is planned to relate pertinent manpower data to each existing and projected waste treatment facility and to make these data and processing services accessible to State and Federal water quality staffs through remote terminals located in their own offices (in the same manner as other water quality data and information services are now available). The data will be continuously updated and maintained through collection of data generated in EPA and State programs for management of waste treatment plant construction and monitoring of plant operation and maintenance.

(3) Developments in Training for Manpower Planning. In cooperation with the Office of Education, Department of Health, Education, and Welfare, a contractor has been engaged to develop a procedures manual and to train representatives of State and local water quality, labor, and education agencies in the concepts and methods of manpower planning. The first workshops were held in December 1971.

The training will encompass information on the structure of the national water pollution control program; the manpower development process; the roles and relationships of Federal, State, and local labor and educational institutions responsible for manpower development; the state of the manpower planning art; and general instructions on the methods and procedures to be applied in manpower planning for municipal waste treatment plants.

2. The Action Planning Component

The second component of the water pollution control manpower development process is the development of action plans upon completion of manpower and training forecasts. The forecasts state the manpower and training needs, and action plans are developed to fulfill those needs and to improve the utilization of available manpower and provide for employee satisfaction.

As indicated in Exhibit II-1, action plans to provide manpower and training can approach the goals from two directions: (i) planning for management programs intended to improve utilization of the existing labor force, for example, by the application of industrial engineering techniques or actions to lower attrition rates by improved working conditions or more competitive compensation; or (ii) planning to increase the size and effectiveness of the work force by providing additional training.

Action plans are in the first instance the responsibility of the employer. Thus, all public and private managers develop action plans for their own spheres of activity. Naturally spheres of activity vary from one type of organization to another.

The action plans of the managers who are building and/or operating water treatment facilities are concerned solely with personnel engaged directly in water pollution control operations.

On the other hand, recruitment, retention, utilization and training action plans of local nonoperating, State, and Federal agencies frequently take on an additional dimension. Of course, these organizations will develop action plans designed to recruit, retain, and utilize or train their own staffs. However, their missions are in part to support the operating managers. Support involves assistance to operating managers in action planning. Therefore, as a part of their programs, these supporting agencies develop action plans to provide technical assistance and training to operating managers to aid them in development of action plans to improve manpower recruitment, retention, and utilization. Further, since many operating managers are not equipped or financed to provide all the training their staffs may require, these supporting agencies often develop action plans for the direct delivery of training to employees of operating managers in addition to their own employees. Planning for delivery of this technical assistance and training may be done by local management and training specialists who perhaps have the best knowledge of local priorities and specific needs. However, because of lack of local resources, such planning is frequently conducted at the State level.

Under the water pollution control manpower development process as currently conceived, EPA, in addition to planning for its own staff needs, provides impetus and financial assistance for the programs at the State and local levels. EPA also provides technical assistance and training in action programming to other Federal agencies having water pollution control activities. EPA engages in the action development of direct-delivery training and other services only to the extent that such training and services are required to fill identified training gaps that will not be filled by others. Thus, for example, EPA has and will continue in the immediate future to plan operator training courses and short update courses for professionals. EPA also develops action programs for the delivery of technical assistance in training, as in the development of curricula and training materials for the use of others in delivering training.

C. The Universe of Water Pollution Control Manpower

As has been briefly noted, the water pollution control manpower planning program is nationwide in scope and potentially covers all water pollution manpower. An estimated 25,000 employers now engage an estimated 149,000 employees to accomplish a broad variety of activities relating to the achievement of the nation's water quality goals. These activities, which provide a frame of reference for the more detailed examination of the water pollution control manpower universe that follows, include:

- Establishment and enforcement of water quality standards.
- Development and administration of basin plans.
- Responses (on the part of polluters) to governmental imposition of standards and to basin actions.
- Management decisions on the part of polluters on acquisition and design of water quality control facilities.
- Operation and maintenance of facilities.
- Government support activities (such as research and development, technical assistance, and training).
- Educational institution activities.
- Consulting engineering.
- Equipment design and supply.

Water quality personnel with a wide variety of skills are needed to perform these functions. For purposes of this report, they are categorized into four overall groups: professionals, technicians, operators, and others. Each of these groups is described in this section of the report. Projections of manpower and training needs for each group are presented in Section D, below.

1. Professionals

Into the professional category fall those jobs that require creative problem-solving ability; the professional is expected to deal with analysis and correction of unusual management or technical problems. Sanitary engineers are the predominant professionals in the field. In addition to their engineering training, they are schooled in life and physical sciences and are commonly employed as planners, designers, administrators, or facility managers. The professional category also includes civil, electrical, and mechanical engineers and architects who

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design and construct facilities, chemical engineers who design and modify treatment processes, and mechanical and electrical engineers who design and operate the electrical and materials handling systems in the larger wastewater treatment facilities and the sewage collection systems. As a result of experience and continuing education, these engineers frequently become specialists in water pollution control activities.

In addition to engineers, the professional category includes scientists who are involved in research, monitoring, and technical supervision. Chemists and microbiologists engage in water analysis in facilities and in streams, while aquatic biologists analyze the effects of pollution on water life. These scientists also participate in the design and analysis of waste treatment processes and water quality measurement systems.

Recently, as the interdisciplinary impact of water pollution control has become more apparent, other professionals have become more closely identified with the field. For example, lawyers, economists, and political scientists are frequently involved in enacting and administering water quality legislation, and management specialists and computer specialists have joined with engineers and scientists to provide interdisciplinary teams to solve water quality problems.

Most professionals come to the water pollution field with professional degrees at the bachelor or higher level. Currently the first professional degree for the sanitary engineer is the masters. The other professionals coming into water pollution ordinarily require additional specialized training in water-related subjects in order to become fully effective in their jobs.

2. Technicians

The technician performs complex but routine analytical tasks which require a knowledge of engineering and/or scientific techniques. This category consists largely of wastewater treatment laboratory technicians who perform chemical and biological tests to analyze influents, treatment processes, and effluent characteristics. They are responsible to verify that the influent is processable and does not contain toxic substances that might deactivate the biological treatment processes. In addition, their analyses enable identification of new pollution sources and provide the basis for determination of treatment charges to industrial polluters. Laboratory technicians monitor treatment processes in various parts of the plant to ensure that the system is working correctly, and they assess the effluent to ensure that the plant is operating to the required minimum performance standards. Particularly large or sophisticated water and/or sewage utilities also utilize electronic technicians to work with telemetry and automated control systems. Other technician level personnel include the draftsmen and survey party personnel who work with the consulting engineering firms and large municipal departments.

Technicians are employed both by treatment facilities and by State agencies charged with surveillance of water pollution.

Some technicians have an associate degree or two years of college, but many technicians actually possess less training, having achieved their positions through long experience and/or OJT. Those formally trained in an academic program frequently require on-the-job training to familiarize them with wastewater treatment problems, and they sometimes attend operator training programs as part of their orientation in order to gain an overall understanding of plant operations.

3. Operators

The operator manpower category includes several levels of personnel who are directly responsible for operation of equipment and systems involved in treating wastewater. While there is considerable confusion in the use of the term "operators," it is possible to identify at least three possible grades of operators, depending on skill, level of responsibility, and experience. The lowest grade of operator is an entry-level job. These operators may have less than a high school education and may have little mechanical experience. They may be responsible for a very small segment of the operation and generally perform both mechanical tasks (such as lubrication, cleaning, and inspection of equipment) and manual labor (such as cleaning out tanks, pumps, and valves). Typically they work under close supervision and normally have little or no particular knowledge of the plant equipment.

The second grade of operators are more experienced and are responsible for operations of part of the plant, or possibly a small plant in its entirety, including the indoctrination of new operators. This level of operator must understand and be able to interpret the indications of the instrumentation in the plant, which reflects the status of various processes; he must be able to diagnose and solve problems on his own initiative and to anticipate the consequences of his actions when problems occur.

The third level of operator includes supervisory personnel such as shift supervisors and plant superintendents who have ultimate operating responsiblity for effectively running a plant. Job responsibilities at this level would include the scheduling of operators, the coordination of maintenance and operations tasks, participation in or making final decisions on staffing levels, budgets, and purchases, and so on. In some plants personnel with these duties will be engineers and, if so, would be classified as professionals rather than operators.

To complicate matters further, in small plants--those that process under one million gallons per day (mgd)--operators frequently perform the duties of all three operator levels. Operators in these small plants often work with only a few colleagues--and frequently no one else--on duty at the same time. The very smallest plants, in fact, are believed to be staffed generally by one part-time operator, leaving no one in attendance the major part of the time. Ideally, these operators should know everything that is going on in the plant and should be able to set up the plant for more or less automatic operations and to correct faulty conditions with a minimum of help. In such environments, the operator is a general supervisor, laborer, technician, maintenance specialist, and janitor, as circumstances dictate.

Experienced operators at all levels, but particularly at the highest level, are rarely available on the job market, although a few have come out of the military where they have operated treatment plants on military installations. Most operators are initially hired at the lowest level with little previous experience but definite mechanical aptitudes, and they are trained on the job.

4. Others

Other job categories include the craftsmen (such as electricians, mechanics, and machinists) who are required for maintenance of wastewater treatment plants; the laborers who support the operators and craftsmen; and clerical and administrative personnel.

Although the nature of plant operations gives maintenance jobs a number of unique characteristics, personnel fulfilling the maintenance function generally require standard craft skills. By definition, craftsmen are already experienced in their trades, and their skills are almost directly applicable to the water pollution control field. In addition to craftsmen, skilled welders and electronics technicians may be employed for maintenance purposes, depending upon the size and specific nature of plant operations. Heavy equipment operators, mechanics, and bricklayers are needed for sewer collection system operation and maintenance. Except for orientation to the job, these personnel rarely receive specialized training. In most cases they are already skilled and are obtained either from the military services or from the local manpower pool.

Large numbers of laborers or related blue-collar workers are employed, predominantly in sewer collection system operation and maintenance activities. They are recruited from the general labor pool and pose a significant manpower development challenge because of their large numbers and generally low scholastic achievement. These workers generally receive job indoctrination but no formal training.

5. Associated Occupations

In addition to those categories discussed above that are directly related to water pollution control activities, other occupations have important supporting inputs into the water pollution control program. Public officials must have an understanding of the wastewater pollution and

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processing cycle. For example, city managers, municipal utilities managers, selectmen, councilmen, and other responsible public officials need to understand broadly what processes are going on inside the plant and the role that trained manpower plays in ensuring plant effectiveness. These people are the sources of local planning and training funds and must appreciate the complexities of and need for funding both activities in addition to the more familiar operating, maintenance, and capital funding programs that are routine.

Personnel in related water quality, water supply, and public health agencies--especially those engaged in surveillance activities--must possess the technical knowledge to recognize good and bad operation of existing equipment. They must also be competent in anticipating potential threats to water quality from accidents, natural phenomena, and the like, and in recommending appropriate correctional measures. Many former operators and technicians now serving in surveillance functions, are capable of such activities, but EPA's estimates of State agency staffing levels indicate that the current supply is insufficient to meet future requirements.

Finally, State and local police, firemen, public utilities workers, housing and industrial park developers, and other related parties must understand the water quality aspects of their jobs. Just as a housing development must be provided the information to control erosion and protect waterways through preventive planning, public workers must be able to administer appropriate corrective measures when unforeseen circumstances threaten to jeopardize a water course--as, for example, in the event that a toxic chemical load spills on a highway near a stream at a point upstream of a municipal water supply intake.

EPA is considering the use of short course orientation techniques to heighten the awareness and competence of the community professionals mentioned above, to enable them to make the correct decisions when faced with the infrequent but potentially catastrophic situations they might someday have to handle.

D. Preliminary Estimates of Current and Future Manpower Requirements and Future Training Needs

Preliminary estimates of manpower and training requirements are presented in this section of the report, with primary focus on:

- Current (FY 1971) manpower requirements, by occupational classification.
- Anticipated (FY 1976) manpower requirements, by occupational classification.

- Future entry and update training requirements, five-year total (FY 1972 - 1976) and average annual, by occupational classification.

These estimates will be refined as current research efforts are completed but must be viewed as subject to a number of qualifications at this time. Subsection 1 below describes the qualifying factors which affect all of the staffing and training inventories and projections, and subsection 2 discusses the methodology used to develop the estimates. Each of the major sectors requiring water pollution control manpower--nongovernment, local, State, Federal non-EPA, and EPA--is described and discussed in subsections 3 through 7; the overall future manpower and training demand in the field of water pollution control and factors that may modify these estimates of future needs are summarized in subsection 8. Conclusions emerging from this analysis appear at the end of this part of the report.

1. Qualifications on Preliminary Estimates

There are several factors that affect the confidence that should be placed on the preliminary estimates that follow, as discussed below. However, despite these qualifications, EPA places high confidence in these estimates as a good reflection of the orders of magnitude of current and future manpower and training needs.

a. Lack of Uniformity in Occupational Classification. In the wastewater collection and treatment field, there is currently a lack of precision and uniformity in manpower terminology, occupational definitions, and job requirements and qualifications. Reference has already been made to the various meanings of the term "operator." Another example is the term "laborer." So-called "laborers" in one agency may be called sewer maintenance men, sewer servicemen, public works maintenance men, or maintenance men in other jurisdictions even though the functions of the jobs are substantially similar. The situation is further complicated by nonstandard classification levels; for example, a Sewer Maintenance Man I in jurisdiction A may perform duties similar or identical to a Sewer Maintenance Man II in jurisdiction B. This lack of uniformity is the result of the multiplicity of independent employers involved in water pollution control.

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b. Inclusion of Manpower Assigned Part Time. In some cases part or all of the water pollution control activities of employers may require the part-time rather than full-time application of skills of one or more employees. This may be due to the small scale of the activities or to the organizational structure of the particular employer. Available data does not permit segregation by quantity of part-time from full-time manpower requirements. However, all of these employees--assigned part or full time to water pollution control--must be specially skilled in this field. Therefore, all manpower estimates in this report include manpower assigned on a part-time basis to water pollution control activities. Thus, for example, the manpower estimates include employees working less than full time in the smaller treatment plants where full-time employment is not considered economically justifiable; industrial plant employees of all classifications whose routine duties include functions in addition to water pollution control; and local government employees whose duties include work in both water supply and waste water collection.

c. Lack of Uniformity in Work Organization. Similar types of employers often organize for water pollution control activities in different ways. For instance, in some states the water pollution functions are largely centered in a water agency, while in others they may be scattered between several agencies such as health, natural resources, and public works. At the local level plants and sewers may be operated as an entity or separately; sometimes management will be plantwide, sometimes citywide, and sometimes regionwide.

d. Lack of Consistency in Projection of Manpower and Training Needs. Many employers do not project manpower and/or training needs; those that do do not necessarily use the same timeframes for projection.

e. New Technology. All estimates are made on the basis of known technologies. In this respect, it is known that wastewater treatment technology is rapidly becoming more sophisticated. Discussion of how some major technological thrusts may affect the manpower picture follows presentation of the data.

2. Methodology

The water pollution control manpower universe has been divided into sectors to facilitate the collection and presentation of data. These sectors are:

--Nongovernmental.
--Local government.
--State government.
--Federal Government, non-EPA.
--EPA.

Within each of these sectors estimates are reported for the four general manpower classifications:

--Professional.
--Technicians.
--Operators.
--Others.[1]

Within each of the sectors, estimates for subgroupings of classifications are shown when they are considered reasonably reliable, such as the breakdown of the professional classification into engineers and scientists. However, no summary analysis below the four general categories can be attempted because of incomplete data.

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[1] The data available for this classification are incomplete. In instances where data are lacking, no estimates of requirements are made in this preliminary forecast. Therefore, to some extent, manpower and training requirements for "Others" are understated in this forecast.

The methodology for determining manpower needs varies from sector to sector because of differences in the information available. Accordingly, the data sources and methodology for each sector are described as that sector is discussed.

Throughout the sectors training requirements were calculated in terms of entry and update training needs; to the extent that it was not possible to take account of future upgrade training needs,[1] the training estimates must be considered conservative. Training required was calculated for the number of personnel engaged, rather than for full-time equivalents, on the assumption that a part-time worker must also be trained.

In the "Others" category, no forecast of entry or update training needs is made for the related blue collar and administrative subcategories since training for these categories is not related directly to water pollution control but is more related to general blue-collar and administrative functions.

Entry training needs were expressed in terms of expansion positions plus manpower hired to fill positions vacated through an estimated 5 percent turnover rate. No consideration could be given to the proportion of people leaving one waste treatment facility to join another; all of the 5 percent were assumed to be leaving the water pollution control field. However, the 5 percent turnover estimate is a conservative one derived from a consensus of non-EPA Federal agencies that turnover in wastewater personnel is currently 5 to 10 percent.

A simple example serves to illustrate the method of calculation for entry training. If the 1971 staffing for a certain class of manpower is 4,200 and the FY 1976 projection for this same category of manpower is 5,600, the projected five-year expansion is 5,600 - 4,200, or 1,400. The average population of this category over the 1971-1976 period is thus assumed to be the 1971 population of 4,200 plus one half of the projected five-year expansion of 1,400--for a total of 4,900. To the average population of 4,900, a five percent attrition rate is applied for each of five years; thus, the predicted five-year turnover is 4,900 x 25%, or 1,200. Total five-year entry training needs are the sum of the projected five-year expansion of 1,400 and the estimated five-year turnover of 1,200--a total of 2,600. In every case, the estimated five-year update training need is rounded to the nearest hundred. The average annual training need over the 1971-1976 period is obtained by dividing the total five-year need by the number of years (five) in the projection period (2,600 divided by 5 = 520).

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[1] It is clear that as new facilities are constructed and as existing facilities become more complex, there will be a pressing need to advance present workers.

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Update training needs were calculated using an apparent consensus of non-EPA Federal agencies regarding the frequency with which the various occupational categories of personnel should ideally receive training in the face of a rapidly changing technology. No distinction is made in these figures with regard to the necessary duration of training or the sources of training (which may be from academic institutions, State-run vocational schools, on-the-job training programs, or even equipment suppliers).

The example above may also be used to illustrate the method used for calculating update training estimates. The average staffing level of the category in the example above was 4,900 for the 1971-1976 period. To derive update training needs, this figure must be multiplied by the number of training instances in the forecast period for that category of personnel--2 1/2 for professionals, operators, and technicians (on the assumption that training is delivered every second year during a five-year period), and 1 2/3 for others (maintenance) (assuming one training experience every third year during a five-year period). Thus, if the 4,900 represents personnel in the professional, operator, or technician category, 4,900 x 2 1/2 = 12,250, the five-year update training need. In every case, the estimated five-year update training need is rounded to the nearest hundred; applying this principle in the example above, the five-year update need is expressed as 12,300. The average annual update training need is calculated by dividing the five-year training requirement by five, the number of years in the forecast period (12,300 divided by 5 = 2,460, the average annual update training need for this example).

3. The Nongovernment Sector

Water pollution control activities outside of the governmental sphere are conducted by several types of institutions and organizations,[1] including:

- Industrial firms, many of which treat their waste material before releasing it into streams or wastewater (sewage) collection systems.
- Educational institutions that train the professional and technically specialized operators to design, build, and operate the water pollution control facilities and equipment.

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[1] While it is recognized that other nongovernmental sectors such as power, mining, agriculture, and transportation employ personnel who are involved in water pollution control activiites, data are not presently available that will support definitive manpower estimates for these sectors. Therefore, these sectors have not been included in this special preliminary estimates of needs. The omission of these sectors will probably cause an overall underestimate of manpower and training needs. These sectors are discussed in Appendix A.

- Consulting engineers, who design pollution control facilities and assist facility operating personnel to obtain the best performance from their plants.

Because each of these employers has unique manpower and training requirements, they are discussed individually in the subsections which follow. The discussion of nongovernmental manpower and training requirements concludes with a set of composite exhibits which display the employer's current manpower estimates (Exhibit II-3), estimated FY 1976 manpower requirements (Exhibit II-4), and estimated FY 1972 - 1976 total and average annual training needs (Exhibit II-5).

a. Industrial Firms That Discharge Wastewater. Approximately 240,000 industrial concerns are discharging approximately 16 trillion gallons of wastewater each year into our streams, lakes, and estuaries--a volume rivaled only by the domestic household waste discharge. Although not all of this discharge is adding foreign polluting substances to the waterways, a significant proportion does so and contributes tremendous heat loads to the environment. Eighty-five percent of the annual wastewater discharge is attributable to four major industry groups:

--Primary metal industries.

--Chemical and allied products.

--Paper and allied products.

--Petroleum and coal products.

The discharge of wastewater from manufacturing facilities is highly concentrated. Approximately 60 percent of the industrial discharges are located in five regions: the Delaware and Hudson River basins; the Ohio River; the Eastern Great Lakes; the Western Great Lakes; and the Western Gulf of Mexico. Establishments with an annual withdrawal of 20 million gallons or more of water account for about 97 percent of water withdrawn for manufacturing purposes. However, these organizations represent only 4 percent--approximately 10,000 establishments--of the total number of manufacturing establishments and employ approximately 45 percent of all U.S. manufacturing workers.

Water pollution control activities in industry consist largely of the establishment and operation of internal wastewater treatment plants, either to provide preliminary treatment of toxic wastes before effluent is released into municipal sewage collection systems or to treat the effluent completely before its ultimate discharge into the waterways. Personnel engaged for water pollution control functions consist predominantly of plant operators and technicians, although professional personnel are used in ever-increasing numbers in treatment process selection, plant design, supervision of operations and maintenance, analysis of industrial effluents to establish treatment requirements, and coordination with municipal utilities to negotiate pretreatment processes and municipal treatment charges for wastewaters discharged into municipal sewer systems.

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Estimated current water quality employment in private industry is based upon the number of plants as shown in the 1968 Census of Water Use in Manufacturing for those industries providng some form of wastewater treatment. This manpower total--over 30,000 persons engaged who devote an average one third of their time, as shown in Exhibit II-3, below--represent the estimated personnel employed by those industries utilizing at least 20 million gallons of water per year for which manpower data were available; it may be considered representative of the order of magnitude of industrial employment in the field, as these industries withdraw from the waterways approximately 94 percent of the water used for manufacturing and discharged in the United States.

Information regarding future manpower and training needs of private industrial concerns in the field of water pollution control was obtained from discussion with the trade associations of the major water users, such as the American Petroleum Institute, National Council for Clean Air and Streams (pulp and paper), Manufacturing Chemists Association, and the American Iron and Steel Institute. At a later date, these estimates will be refined by two major sources of information: an American Association of Professors in Sanitary Engineering (AAPSE) survey of industry representatives to determine the effect of changes in standards and enforcement on their manpower requirements, and an EPA poll of 10,000 industries to determine their projected professional and technical manpower and training requirements. Although neither of these surveys will be complete before mid-1972,preliminary returns have been used in compiling the best possible estimates which can be made at this time.

As shown in Exhibit II-4, below, manpower needs in all occupational categories are expected to rise considerably. The FY 1972-1976 period will witness a continuation of the current trend of using personnel actively engaged in some other production process of the industry to supervise the personnel conducting industrial wastewater treatment operations. Therefore, the increase in professional personnel will be largely in process functions, and people now devoting a small portion of their time to handling water quality responsibilities will allocate more time to wastewater concerns. While the professionals hired into the industrial wastewater treatment positions will require training specifically focused on water concerns because of their process-oriented responsibilities, little increased burden from this sector is expected on those educational institutions that now educate sanitary engineers. Rather it is reasonable to expect that educational institutions will utilize an increasing portion of their resources to deliver specialized short courses to accommodate the needs of new industrial entrants and others in need of similar training. Finally, with regard to the training of professionals to perform wastewater functions in industry, representatives of the major water-using industries believe that it is easier to train a man familiar with an industry to deal with wastewater problems than to train an environmental specialist to familiarize him with the industrial process. In the future, the largest plants may be expected to employ at the corporate level a specialist in process operation and control, as well as a design group to provide internal plans for pollution abatement and control; few environmental specialists will be required even at the corporate level.

The greatest need for operators and technicians will be experienced in industries affected by requirements to increase or improve their water pollution control activities. The need will have to be met partially by upgrading existing personnel and partly by hiring new personnel, who will receive intensive but brief training. As water quality standards are refined and enforcement becomes more stringent, the number of small treatment plants and facilities will increase, and the scale of effort in larger plants will be intensified.

Higher reliability requirements and the more sophisticated processes necessary to achieve higher treatment level may be expected to have a great impact on the manpower and training needs of industries engaged in water quality activities. Increased automation may reduce the total number of operators but will require higher skills in the operators and technicians needed to calibrate and control the more sophisticated facilities. Such changes must be coordinated with both trade unions and management if they are to be implemented smoothly. Manpower planning in these industries must be intensified to anticipate these needs and to program increasingly specialized training.

The most significant influence on the industrial water quality manpower projections set forth in Exhibit II-4 is the possibility that the imposition of Federal water quality standards on all industry--including the 230,000 industries not included among the major water users--will require every industrial concern to employ or have access to at least one individual to assume water pollution control responsibilities. Such an event would significantly increase the manpower needs in total numbers, but it is not possible to determine the extent of that increase or to anticipate the distribution of these requirements among the various occupational categories of personnel.

In light of these considerations, it appears that industrial employers of water quality personnel will experience sizable increases in the need for trained personnel in the FY 1972 - 1976 period and that the nature of training delivered will increase in technological sophistication at all levels. Estimates of the average annual industrial water quality training load needed to maintain progress in the efforts to control water pollution have been calculated in accordance with the methodology described in subsection 2, above, and are presented in Exhibit II-5, below.

b. Educational Institutions That Train Water Pollution Control Professionals and Technically Specialized Operators. Of the educational institutions providing sanitary engineering curricula, over 60 percent--

87 institutions--receive EPA grants in support of their sanitary engineering programs. Manpower employed by these educational institutions consists almost entirely of engineers, scientists, and technicians who perform activities in teaching, research, curriculum planning, and advisory consulting to government agencies and consulting engineering firms. The ratio of technicians to professionals in this subsector is approximately one or two to one, and the total number of technicians employed in these 87 institutions is under 1,000; most technicians hold bachelors' degrees and are responsible to collect data and conduct laboratory experiments in research areas, and few technicians teach. A number of graduate students also serve as teaching fellows and research fellows, but they are not included in the educational water quality manpower inventory because they are still active students. The current inventory is included in Exhibit II-3, below.

It is estimated that educational institutions are now operating at two thirds of their capabilities to produce trained professionals and that they would be able to produce 50 percent more if the job openings existed to create the educational demand. However, realization of this capacity would necessitate a complete diversion of current staff from research to teaching--which is, of course, unrealistic. The true expansion factor for the production of trained professionals using only the existing teaching force is therefore something less than 50 percent. For this reason, educational institution manpower in water quality is expected to experience little change between FY 1971 and FY 1976, as shown in Exhibit II-4, below. Because personnel working in wastewater areas in educational institutions are generally involved in research, Exhibit II-5 assumes (conservatively) that they have no need for further training from sources outside their own organizations.

c. Manufacturers of Wastewater Analysis and Treatment Equipment and Chemicals. The wastewater equipment and chemical suppliers represent the most diverse groups that employ professional and technical water pollution control personnel. Services provided by this group range from turn-key type operations, which provide everything required for a completed treatment facility, to the sale of chemicals. The professionals performing the various functions possess all types of academic backgrounds, and it would be essentially impossible to use a general classification scheme for the entire industry. However, the largest employers of professional and technical personnel are the major equipment manufacturers, most of whom appear to allocate a similar percentage of their effort to their various business functions regardless of the size of their professional staff.

In the absence of a detailed census of the entire industry, estimates of the current and projected manpower inventory for these major manufacturers were derived on the basis of a number of calculations and assumptions. The ratio of professionals (engineers and scientists) to sales volume--assuming that the majority of engineers and scientists are employed in product engineering, sales, and research and development activities--and the ratio of technicians to professionals (2 to 1) were

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calculated on the basis of a representative sample of major equipment manufacturers. On the basis of a 1968 survey of the market for wastewater treatment equipment[1] and the 1971 Water Pollution Control Federation Yearbook, which lists the majority of the large equipment manufacturers, it was determined that the total number of firms handling the majority of equipment sales has changed very little in the past two or three years, even though the total number of manufacturing concerns has increased. Finally, past trends in the proportion of water pollution control expenditures that were allocated for equipment and projected total expenditures through FY 1976 were combined to provide the basis for the estimated expansion in manpower needs.

As shown in Exhibit II-3, below, total FY 1971 water-quality-related manpower employed by major equipment manufacturers totaled just over 4,000, entirely in the professional and technician categories. This is a significant increase over the approximately 1,500 figure experienced in FY 1968. The rate of capital investment is expected to grow between FY 1972 and 1976, increasing manpower requirements in this subsector to over 5,000, as shown in Exhibit II-4. However, it is not anticipated that the demand for environmental specialists will increase significantly in this segment of the industrial market. In addition, the industry will not require a significant amount of training originating outside the individual firms, largely because it employs personnel with previously established qualifications and provides internal training as necessary to perform its product engineering, manufacturing, and marketing functions.

d. Consulting Engineers in Design and Operations. Consulting engineering organizations represent one of the major types of employers of water pollution control specialists. Water quality personnel employed by such firms engage in such activities as water resource planning, preliminary engineering studies, feasiblity and economic studies, process selection and evaluation, preparation of plans and specifications, construction administration, resident engineering supervision, plant start-up and consultation, and monitoring of systems. In the smaller engineering firms, a staff of two or three professionals are involved in all of these activities, while larger firms will be more specialized, with professionals who are involved in only segments of a project and a senior engineer assigned the task of coordinating the various phases.

The current manpower inventory of the water pollution control consulting engineering firms was calculated on the basis of a ratio between staffing levels and receipts developed from data on 11,000 firms representing approximately 70 percent of the total receipts for architectural and engineering services. Assuming that these ratios, calculated on 1967 data, remained constant through FY 1976 in a field which experienced little increase in total manpower, actual and projected total capital expenditures for 1971 and 1976 were used to calculate the current total manpower inventory and projected manpower requirements. These figures are included in Exhibits II-3 and II-4, respectively.

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[1] K. L. Kollar and W. G. Youngwirth, "A Growing Market for Water and Wastewater Treatment Equipment," *Water & Sewage Works*, 1970, pp. 319-325.

The majority of both large and small firms are engaged in both water supply and water pollution control activities. Based upon the fees received by consulting firms for water-related activities as reported in the 1967 census reports,[1] it appears that many of the 5,100 water pollution control specialists listed by the Water Pollution Control Federation Yearbook in 1967 were devoting much of their professional efforts toward activities unrelated to water pollution control. This is further supported by the 1971 WPCF Yearbook, which reported a total of only 5,600 professionals, although the expenditures for water pollution control facilities had increased by a factor of 2 1/4 since 1967.

Information provided by the Consulting Engineers Council also tends to indicate that there has been little change in the number of professionals employed by consultants engaged in water pollution control activities since 1967. Instead, there has been a redirection of effort on the part of water pollution control specialists within these firms. The majority of the consulting firms contacted have indicated that an increase in expenditures by a factor of two or even three would have little impact on their manpower needs. Apparently significant numbers of personnel were hired by the consulting firms during the middle 1960's in anticipation of a boom in water pollution control expenditures that never materialized. Most of these firms have maintained the personnel hired during that period but have until recently assigned them to other professional activities. Now that the anticipated increase in funds for water pollution control facilities is beginning to materialize, these firms have been able to redirect the efforts of these specialists back to water pollution control activities and apparently have not yet reached full capacity. Therefore, as shown in the appropriate columns of Exhibits II-3 and II-4, only a modest increase is expected in the number of professional and technical personnel employed by water pollution control consulting firms between FY 1971 and FY 1976. Because the FY 1971 inventory of manpower was calculated rather than directly counted, it may not account for personnel who were laid off between 1968 and 1971. For this reason, the current manpower inventory may be slightly high, an error which should not affect the FY 1976 manpower projection.[2]

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[1] 1967 Census of Business--Selected Services--Architectural and Engineering Firms, U. S. Department of Commerce, Bureau of the Census, December 1970.

[2] In order to develop a more definitive estimate of the need for consulting engineers in water pollution control, the Consulting Engineers Council and the American Association of Professors in Sanitary Engineering are presently conducting a survey of the industry for EPA. The results of this survey should be available in 1972.

EXHIBIT II-3
NONGOVERNMENT SECTOR--
FY 1971 MANPOWER ENGAGED IN WATER QUALITY ACTIVITIES*

Occupational Category	Industrial Firms	Educational Institutions	Equipment Manufacturers	Consulting Engineers	Total
Professional	3,700	700	2,000	6,800	13,200
Operator	15,400	-	-	-	15,400
Technician	7,200	1,000	2,300	10,000	20,500
Other					
Maintenance	4,700	**	**	**	4,700
Related Blue Collar	**	**	**	**	**
Administrative	**	**	**	**	**
[Subtotal]	[4,700]	**	**	**	[4,700]
TOTAL	31,000	1,700	4,300	16,800	53,800

*Estimate includes manpower assigned on a part-time basis to water pollution control activities. See II D.1., above.

**Data unavailable.

EXHIBIT II-4
NONGOVERNMENT SECTOR--
PROJECTED FY 1976 MANPOWER ENGAGED IN WATER QUALITY ACTIVITIES*

Occupational Category	Industrial Firms	Educational Institutions	Equipment Manufacturers	Consulting Engineers	Total
Professional	12,100	700	2,400	8,200	23,400
Operator	48,700	-	-	-	48,700
Technician	23,100	1,000	2,800	12,000	38,900
Other					
Maintenance	15,100	**	**	**	
Related Blue Collar	**	**	**	**	**
Administrative	**	**	**	**	**
[Subtotal]	[15,100]	**	**	**	[15,100]
TOTAL	99,000	1,700	5,200	20,200	126,100

*Estimate includes manpower assigned on a part-time basis to water pollution control activities. See II D.1., above.

**Data unavailable.

The need for training in the consulting field will be concentrated in short courses for update training to keep abreast of technology in both professional and technical job categories and will represent a relatively small effort, as illustrated in Exhibit II-5. Since the current inventory of personnel in the consulting field is estimated to be 16,800 (Exhibit II-3) and since each of these will require update training every other year, the training requirement will be substantial. Further, because of the diverse locations of consultants, the training will be required at locations throughout the country. It is desirable that planning activities include provision for training these employees of consulting firms.

EXHIBIT II-5

NONGOVERNMENT EMPLOYERS--ESTIMATED FY 1972-1976 ENTRY AND UPDATE WATER QUALITY TRAINING REQUIREMENTS

(Five-year Total and Average Annual)

OCCUPATIONAL CATEGORY	ENTRY PERSONNEL		PERSONNEL FOR UPDATE TRAINING	
	5-Year Need	Average Annual Need	5-Year Need	Average Annual Need
Professional				
Engineer*	14,500	2,900	44,000	8,800
Scientist*	300	100	2,200	400
[Subtotal]	[14,800]	[3,000]	[46,200]	[9,200]
Operator*	41,300	8,300	80,100	16,000
Technician*	25,800	5,200	74,000	14,800
Other				
Maintenance**	12,900	2,600	16,500	3,300
Related Blue Collar	-	-	-	-
Administrative	-	-	-	-
[Subtotal]	[12,900]	[2,600]	[16,500]	[3,300]
TOTAL	94,800	19,100	217,000	43,300

*To receive update training every second year.

**To receive update training every third year.

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4. The Local Sector

Local agencies--under the authority of either municipal governments or collective groupings of local governments (such as sanitary districts or metropolitan district commissions)--are the operators and maintainers of sewage collection and wastewater treatment facilities. Approximately 13,000 communities in this country have sewer systems, either with or without wastewater treatment plants; there are about 12,500 wastewater treatment plants currently in operation. These facilities range from simple lagoons to advanced tertiary treatment plants.

Water quality manpower at the local level is required to perform several kinds of activities. In municipal agencies, for example, personnel who develop, manage, operate, and maintain sewage and storm water collection and treatmen systems engage in many tasks, including overall system management, system planning, design, construction inspections, maintenance, and utility billing. These broad areas involve many detailed subfunctions, such as pumping station design, operation, and maintenance; combined sewer overflow regulator facility design, operation, and maintenance; design, operation, and maintenance of the various types of sewers, drainage channels, and combined sewer overflow treatment or control facilities; catch basin construction and maintenance; review of plans and inspection of construction of sewer connections; enforcement of sewer use and industrial waste disposal ordinances, including the elimination of illicit connections; and infiltration control.

Within the local agency, the organization of these functions varies. Sewage collection system maintenance personnel are often combined with water distribution personnel because of the similar coverage of the respective piping networks; on the other hand, wastewater treatment plant operations and maintenance forces are sometimes separated organizationally because their functions require different skills or because a municipality or district has centralized all maintenance functions.

Estimates of current local agency manpower inventories were calculated on the basis of available data; a complete local manpower census is not yet available. An inventory of all existing wastewater treatment plants was obtained through the EPA STORET computer information system. The inventory was stratified by plant capacity, and the average capacity within each stratum was calculated. Then the preliminary results of a research effort into actual staffing levels in wastewater treatment plants was applied to the total number of plants within each stratum to derive the estimated current manpower inventory at the local level. The current inventory estimate at the local level is shown in Exhibit II-6.

In addition to overall manpower data, analysis of the STORET information revealed an important pattern of operator employment at different sized plants. As indicated by Exhibit II-7, the smaller plants, those of one million gallons per day or less capacity, serve 10 percent

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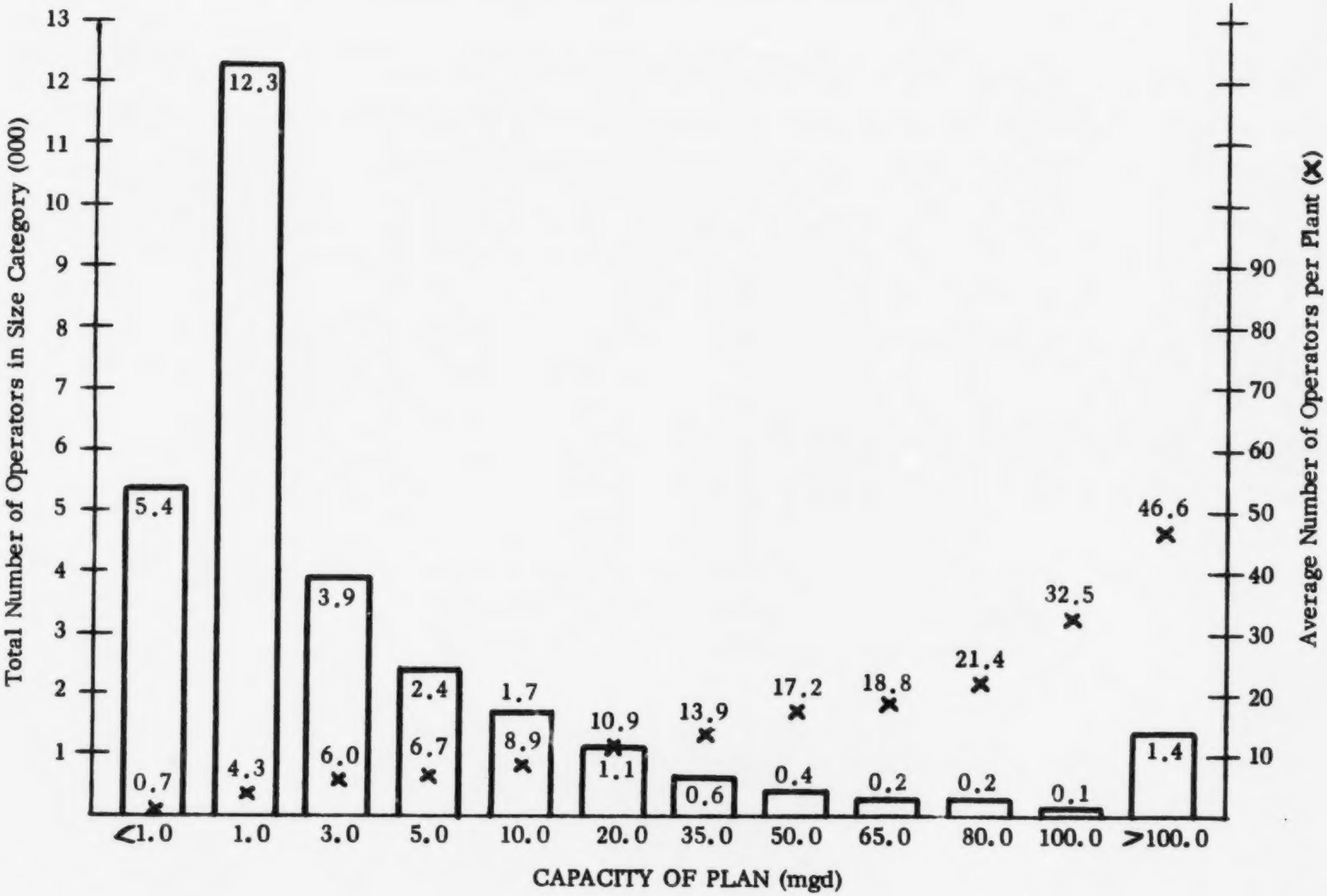
EXHIBIT II-6
LOCAL GOVERNMENT EMPLOYERS--
FY 1971 WATER QUALITY MANPOWER INVENTORY AND PROJECTED FY 1976 MANPOWER REQUIREMENTS

Occupational Category	Wastewater Treatment		Sewage Collection		Design and Administration		Total	
	1971	1976	1971	1976	1971	1976	1971	1976
Professional								
Engineer	1,400	1,800	1,600	2,000	600	800	3,600	4,600
Scientist	200	300	200	300	300	400	700	1,000
[Subtotal]	[1,600]	[2,100]	[1,800]	[2,300]	[900]	[1,200]	[4,300]	[5,600]
Operator	29,700	38,600	-	-	-	-	29,700	38,600
Technician	3,200	4,200	-	-	800	1,000	4,000	5,200
Other								
Maintenance	2,100	2,700	1,200	1,600	-	-	3,300	4,300
Related Blue Collar	9,200	12,000	25,700	33,400	-	-	34,900	45,400
Administrative	400	500	-	-	100	200	500	700
[Subtotal]	[11,700]	[15,200]	[26,900]	[35,000]	[100]	[200]	[38,700]	[50,400]
TOTAL	46,200	60,100	28,700	37,300	1,800	2,400	76,700	99,800

EXHIBIT II-7
OPERATOR DISTRIBUTION BY PLANT CAPACITY



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of the total population tied into sewer systems and employ an estimated 60 percent of all operators. At the other end of the spectrum are large plants, those with a capacity of 100 mgd or more, which employ about 5 percent of the operators and serve 30 percent of the population using sewer systems.

Projections of future local agency manpower needs were derived from initial returns of a questionnaire administered to local water quality agencies by the Department of Labor. The projected FY 1976 manpower requirements should increase by approximately 30 percent between FY 1971 and 1976 in all categories.

Calculated training needs--which include the training load caused by newly created jobs, replacements for turnover, and requirements for new skills--are presented in Exhibit II-8. The estimated entry training needs were calculated on the basis of a 5 percent turnover rate, which is particularly low for the local sector. Field research in municipal wastewater treatment plants indicated that turnover runs particularly high at the local level, and as high as 50 percent or more in new facilities. Although top supervision is usually brought in to the new plant from another location, the plant must be staffed locally. Because the plant must be brought on line quickly and because there is no excess supply of trained wastewater treatment workers, plant supervisors must hire any interested local personnel and train them rapidly. The new plants become operational under the guidance of the designers and engineering consultant to ensure their effectiveness, but usually a short time after the plant is turned over to its own operating force, a number of employees leave their jobs. In many cases this is because inexperienced personnel had to be hired who had no previous exposure to the realities of wastewater treatment; in other cases it is a result of misunderstandings regarding required working hours (rotating shifts, 24 hour "on-call" responsibility, and so on), pay, and other characteristics of the job. Although employee tenure rises markedly after the first year, with turnover in some cases falling almost to zero, the rapid expansion of the total number of treatment facilities suggests that training requirements caused by the need to replace turnover positions are greater than indicated by use of the 5 percent turnover rate.

EXHIBIT II-8
LOCAL GOVERNMENT EMPLOYERS--ESTIMATED FY 1972-1976 ENTRY AND UPDATE WATER QUALITY TRAINING REQUIREMENTS
(Five-year Total and Average Annual)

OCCUPATIONAL CATEGORY	ENTRY PERSONNEL		PERSONNEL FOR UPDATE TRAINING	
	5-Year Need	Average Annual Need	5-Year Need	Average Annual Need
Professional				
Engineer	2,000	400	10,300	2,100
Scientist	500	100	2,100	400
[Subtotal]	[2,500]	[500]	[12,400]	[2,500]
Operator	17,400	3,500	85,300	17,100
Technician	2,400	500	11,500	2,300
Other				
Maintenance	2,000	400	6,300	1,300
Related Blue Collar	-	-	-	-
Administrative	-	-	-	-
[Subtotal]	[2,000]	[400]	[6,300]	[1,300]
TOTAL	24,300	4,900	115,500	23,200

5. The State Sector

Water pollution prevention, abatement, and control activities of the states are the focal points for the effective accomplishment of national goals and priorities in water quality. Because of their critical role and the scope of their responsibilities, the functions of the State agencies cover all activities necessary to ensure the protection of water quality within the State. These activities parallel and expand upon the activities of the Environmental Protection Agency as necessary to conduct a systematic program within the State. Typical State water pollution control activities include:

- Planning of State policies and programs.
- Standard setting, surveillance, and enforcement.
- Regulation of facilities installation and operation (including waste discharge permit issuance, engineering reviews, facility certification, inspection, grants administration, and certification and/or training of operators. This activity normally does not include actual management or operation of waste treatment facilities).
- Analysis of wastewater treatment facility needs, and establishment of priorities and schedules.
- Research and development as appropriate to the particular problems and needs of each state.

Organization to accomplish these functions within the states ranges from centralized water pollution control agencies to a diffusion of responsibilities among several State agencies operating with relatively unstructured coordination. Because of the nature of the State role with regard to water pollution control, State water quality agencies tend to require a higher proportion of professional personnel than are needed at the local level.

Current water quality staffing at the State level was determined on the basis of the State Program Grant Applications[1] for FY 1971. Where available, appropriate sections of the FY 1972 grant applications were reviewed to determine whether significant changes in staffing levels had occurred or were anticipated. Concurrently, a manpower model[2] developed by the Office of State and Interstate Programs for issuance as guidance to the states for preparation of plans, was applied to the 1971 inventory estimate. This model uses the program authority, functions, and activities of each State as reflected in its plan, and, without reference to existing staffing levels, it applies work-load factors to establish gross man-year estimates for each major function. The figures obtained in this way represent the man-loading considered to be essential to the maintenance of an effective program.

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[1] State Program Grant Applications are submitted to EPA by the states pursuant to Section 7 of the Federal Water Pollution Control Act.

[2] W.R. Hager, Guidelines for Estimating Personnel Requirements for State Water Quality Control Agencies, Environmental Protection Agency, December 1970.

The review of the 1971 State staffing plans yielded a current total of 2,936 full-time equivalent positions covered by actual positions. The calculations from the model generated a current need for 8,333 full-time equivalent positions (which cannot be translated into actual positions). Although the need represented by the difference between 8,333 and 2,936 positions is current, practical considerations prevent immediate acquisition of personnel to satisfy needs because the required staffing is approximately 2.5 times the current levels.

The ratio of actual State manpower to manpower requirements as projected by the model is are not uniform from state to state, some states having 20 percent or less than the amount of full-time equivalent manpower necessary to perform current functions. The nine states with the greatest combined need appear to have only 30 percent of the manpower needed to perform required functions, while the nine states with the smallest combined needs appear to have manpower equal to 255 percent of the needs. Because FY 1976 manpower projections from the states were not available, the manpower estimate derived from the model was used for the purposes of this report to represent a reasonable goal for 1976 staffing.

The current manpower inventory and 1976 manpower projection for State agency manpower requirements are shown in Exhibit II-9. It must be emphasized that both of these figures represent man-years actually applied toward and needed for performing required functions, not positions to be filled, and therefore should be viewed as estimates of full-time equivalent staffing. In addition, both of these estimates rest on the assumptions that the current estimate of overall occupational mix, as calculated from the State grant applications, is accurate and that major changes in the required occupational mix will not occur during the five-year manpower projection period.

On the basis of the projected manpower increase that will be required at the State level between FY 1971 and 1976, estimated entry and proficiency water quality training requirements were calculated, as shown in Exhibit II-10. It is particularly important, of course, for the states' personnel to receive the necessary training because of their role in surveillance, enforcement, and--potentially--troubleshooting the operation of substandard treatment plants. Competent personnel at the State level, to be produced largely through short-course training involving surveillance methods and technology updates, will be relied upon to maintain satisfactory national water quality.

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EXHIBIT II-9
STATE GOVERNMENT EMPLOYERS-- FY 1971 WATER QUALITY MANPOWER INVENTORY AND PROJECTED FY 1976 MANPOWER REQUIREMENTS

Occupational Category	FY 1971 Staffing	FY 1976 Projection
Professional		
Engineer	1,500	3,900
Scientist	600	1,600
[Subtotal]	[2,100]	[5,500]
Operator	-	-
Technician	300	700
Other		
Maintenance	-	-
Related Blue Collar	-	100
Administrative	1,200	2,000
[Subtotal]	[1,200]	[2,100]
TOTAL	3,600	8,300

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EXHIBIT II-10

STATE GOVERNMENT EMPLOYERS--ESTIMATED FY 1972-1976 ENTRY AND UPDATE WATER QUALITY TRAINING REQUIREMENTS

(Five-year Total and Average Annual)

OCCUPATIONAL CATEGORY	ENTRY PERSONNEL		PERSONNEL FOR UPDATE TRAINING	
	5-Year Need	Average Annual Need	5-Year Need	Average Annual Need
Professional				
Engineer	2,600	500	6,000	1,200
Scientist	1,300	300	3,000	600
[Subtotal]	[3,900]	[800]	[9,000]	[1,800]
Operator	-	-	-	-
Technician	500	100	1,300	300
Other				
Maintenance	-	-	-	-
Related Blue Collar	-	-	-	-
Administrative	1,200	200	-	-
[Subtotal]	[1,200]	[200]	-	-
TOTAL	5,600	1,100	10,300	2,100

6. The Federal Sector, Non-EPA

A significant number of Federal agencies, bureaus, and departments have primary and secondary missions, tasks, and functions that are directly or indirectly related to the water quality effort of the Environmental Protection Agency. The water pollution control functions in which these agencies engage are indicated in Exhibit II-11. In addition, Executive Order 11507 requires all Federal organizations to be exemplary in the abatement and control of water pollution arising from their respective facilities.

Because of the wide variety of missions among these Federal organizations, Federal water pollution control activities are conducted in or impact upon every State, territory, and possession. Specifically, water quality personnel in such agencies perform a broad spectrum of pollution control functions, including policy formulation, development of quality standards, monitoring and surveillance, research, hygiene, training, design, construction of facilities, and operation and maintenance of water supplies, sewage collection systems, and wastewater treatment plants. These agencies operate and maintain a total of 9,320 wastewater treatment facilities, ranging in capacity from under 1,000 to over one million gallons per day. (A summary of Federal wastewater treatment facilities by size and type is included in Appendix B.) Most Federal treatment facilities are for primary or secondary treatment of sanitary wastes, and nearly 200 plants provide tertiary treatment.

According to the results of a July 1971 EPA (Office of Water Programs) survey of 40 Federal agencies, bureaus, and departments, 24 were identified as currently employing personnel who devote 25 percent or more of their time to water pollution control activities. On the basis of a 100 percent response, it appears that a total of almost 13,000 personnel are currently employed by Federal agencies outside of EPA to perform water quality functions. As shown in Exhibit II-12, this employment is projected to approach 16,000 by 1976--an increase of over 25 percent. This figure is probably conservative in that it represents projected employment, rather than needs.

Operaors make up the largest employment category in the Federal, non-EPA water quality work force, and they are expected to continue to do so in FY 1976. The operator category is projected to experience the greatest rate of growth (approximately 36 percent) during the FY 1972-1976 period, with the increase in engineers following closely (35 percent).

The survey data indicate that employment varies considerably among the non-EPA Federal organizations, with current water pollution control personnel ranging from one to more than 3,700. Projected FY 1976 agency manpower requirements range from one to more than 4,100. Seventeen of the 24 agencies reporting manpower requirements indicated that their needs would increase between FY 1971 and FY 1976, while the others remain relatively constant.

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KEY: [x] Function Performed

■ = Organizational Components Reported

EXHIBIT II-11
FEDERAL ORGANIZATIONAL FUNCTIONS IN THE WATER POLLUTION CONTROL FIELD

Federal Activities	Policy Formulation	Standards Development	Regulations, Licensing & Permits	Program & Tech. Planning	Monitoring, Surveillance, & Investigations	Enforcement	Procurement & Contracts	Grants	Research	Methods Development	Hygiene	Design & Spec. Dev.	Constr. & Installation	O&M Waste Treatment Plant	O&M Water Supply Systems	O&M Sewer Systems	Conservation	Training	Information Dissemination	Consultation	No Function
Department of Defense	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Defense Supply Agency	x						x							x							
Army Surgeon General	x	x	x	x	x	x			x	x	x							x	x	x	
Corps of Engr.-Mil	x	x	x	x	x		x			x		x	x	x	x	x	x	x	x	x	
Army Commands	x		x	x	x		x							x	x	x		x	x		
Navy	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	
Air Force	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	
Corps of Engr. Civil	x	x	x	x	x	x	x		x	x		x	x	x	x	x	x	x	x	x	
Department of Agriculture	x	x	x	x	x		x	x	x	x	x						x	x	x	x	
Agric. Res. Service		x		x	x		x	x	x	x	x						x		x	x	
Forest Service	x		x	x	x	x	x		x	x		x	x	x	x		x	x	x	x	
Department of Commerce	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Maritime Adm.	x		x			x															
Nat. Oceanic & Atmos.	x	x							x										x		
Nat. Bureau of Standards														x							
Nat. Marine Fisheries Ser.	x						x										x		x		
Atomic Energy Commission	x	x	x	x	x	x	x		x	x											
General Services Adm.							x							x		x			x		
HEW - PHS - NIH - NIMH														x	x	x					
Department of the Interior	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Indian Affairs				x	x		x				x	x	x	x	x		x		x	x	
Land Management	x	x	x	x	x	x					x			x			x		x	x	
Mines	x	x	x				x	x											x	x	
Nat. Park Ser.	x		x				x				x	x	x	x			x		x		
Reclamation	x		x				x					x		x	x		x		x	x	
Sport Fish & Wildlife	x						x							x			x		x		
Geological Survey	x	x	x	x	x		x	x	x	x		x					x	x	x	x	
Department of Justice	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Prisons														x	x						
NASA										x				x							
Post Office Dept.							x														
Smithsonian Institute																					x
Tennessee Valley Auth.	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x		x	x	
Dept. of Transportation	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Coast Guard	x	x	x	x	x	x	x		x	x				x					x		
Fed. Aviation Adm.							x					x		x							
Fed. Railroad Adm.									x												
St. Lawrence Seaway	x		x		x	x	x							x							
Veterans Adm.							x														
Environmental Protection Ag.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Radiation	x	x	x	x	x	x	x	x	x	x	x							x	x	x	
Pesticides	x	x			x	x													x	x	
Solid Waste	x	x			x	x													x	x	
Water	x	x	x	x	x	x	x	x	x	x	x	x					x	x	x	x	
Housing & Urban Dev.							x	x				x							x	x	
Treasury Dept.	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Mint																					x

EXHIBIT II-12
NON-EPA FEDERAL SECTOR -- FY 1971 AND PROJECTED FY 1976 MANPOWER ENGAGED IN WATER QUALITY ACTIVITIES

OCCUPATIONAL CATEGORY	FY 1971 STAFFING	FY 1976 PROJECTIONS
Professional		
Engineer	2,300	3,200
Scientist	2,300	2,700
[Subtotal]	[4,600]	[5,900]
Operator	4,200	5,600
Technician	1,800	2,000
Other		
Maintenance	800	900
Related Blue Collar	-	-
Administrative	1,100	1,400
[Subtotal]	[1,900]	[2,300]
TOTAL	12,500	15,800

On the basis of a consensus of the reporting from other Federal agencies, EPA derived estimates of the frequency with which water quality personnel employed by those agencies should ideally receive update training to ensure that they are aware of the most current technological advancements. The projected training needs of these agencies, on the basis of their own manpower projections and frequency-of-training consensus, is presented in Exhibit II-13 in terms of the total five-year need and the average annual need. Because these activities also provided information regarding the number of personnel planned to receive training in FY 1976, the non-EPA agencies' FY 1976 training needs were also calculated by the above method. Comparison of the stated training plans and calculated training needs, as in Exhibit II-14, indicated that even though the agencies had not expressed their training projections by type of training (entry, upgrade, and update), their plans would reach far fewer employees than might legitimately benefit from receiving water pollution control training during FY 1976. The gap between training needs and training plans would be even greater were the total FY 1972-1976 period to be examined in this way. The agencies' training plans to show inclusion of water quality training in the plans of 16 of the 24 non-EPA Federal water quality employers, and it is promising to note that a 50 percent increase in training volume is anticipated.

EXHIBIT II-13
NON-EPA FEDERAL SECTOR -- ESTIMATED
FY 1972-1976 ENTRY AND UPDATE WATER QUALITY TRAINING REQUIREMENTS
(Five-Year Total and Average Annual)

OCCUPATIONAL CATEGORY	ENTRY PERSONNEL		PERSONNEL FOR UPDATE TRAINING	
	5-Year Need	Average Annual Need	5-Year Need	Average Annual Need
Professional				
Engineer	1,600	320	6,900	1,380
Scientist	1,000	200	6,300	1,260
[Subtotal]	[2,600]	[520]	[13,200]	[2,640]
Operator	2,600	520	12,300	2,460
Technician	700	140	4,800	960
Other				
Maintenance	300	60	1,400	280
Related Blue Collar	-	-	-	-
Administrative	-	-	-	-
[Subtotal]	[300]	[60]	[1,400]	[280]
TOTAL	6,200	1,240	31,700	6,340

EXHIBIT II-14
NON-EPA FEDERAL SECTOR--COMPARISON OF FY 1976 WATER QUALITY TRAINING PLANS AND ESTIMATED NEEDS

OCCUPATIONAL CATEGORY	TOTAL NUMBER TRAINED FY 1971	TOTAL NUMBER TO BE TRAINED FY 1976	CALCULATED ANNUAL TRAINING NEEDS	
			ENTRY	UPDATE
Professional				
Engineer	300	320	400	1,380
Scientist	200	200	100	1,260
[Subtotal]	[500]	[520]	[500]	[2,640]
Operator	500	520	500	2,460
Technician	200	140	100	960
Other				
Maintenance	100	60	100	280
Related Blue Collar	-	-	-	-
Administrative	-	-	-	-
[Subtotal]	[100]	[60]	[100]	[280]
TOTAL	1,300	1,240	1,200	6,340

7. Environmental Protection Agency

The Environmental Protection Agency is the lead agency in the Federal Government's program of water pollution research, abatement, and control. The Office of Water Programs of EPA is responsible for ensuring a coordinated and effective Federal effort to protect and enhance the quality of the nation's water resources. Because the role of EPA in water quality requires a variety of financial administration, research, standard-setting, surveillance and enforcement, technical assistance, manpower development, and planning activities, its current water quality manpower inventory is comprised largely of technicians, scientists, engineers, management, and administrative/clerical personnel. As shown in Exhibit II-15, the current (FY 1971) manpower inventory is projected to increase by over 50 percent, to 4,200, by 1976 as a result of current EPA program plans. Exhibit II-16 projects the estimated FY 1972-1976 update training requirements that will be created by such rapid growth in the EPA water quality program.

EXHIBIT II-15
ENVIRONMENTAL PROTECTION AGENCY -- FY 1971 AND PROJECTED FY 1971 AND PROJECTED FY 1976 MANPOWER ENGAGED IN WATER QUALITY ACTIVITIES

OCCUPATIONAL CATEGORY	FY 1971 STAFFING	FY 1976 PROJECTIONS
Professional		
Engineer	600	900
Scientist	600	900
[Subtotal]	[1,200]	1,800
Operator	-	-
Technician	300	450
Other		
Maintenance	-	-
Related Blue Collar	-	-
Administrative	1,300	1,950
[Subtotal]	[1,300]	1,950
TOTAL	2,800	4,200

EXHIBIT II-16
ENVIRONMENTAL PROTECTION AGENCY--ESTIMATED FY 1972-1976 ENTRY AND UPDATE WATER QUALITY TRAINING REQUIREMENTS
(FIVE-YEAR TOTAL AND AVERAGE ANNUAL)

OCCUPATIONAL CATEGORY	ENTRY PERSONNEL		PERSONNEL FOR UPDATE TRAINING	
	5-YEAR NEED	AVERAGE ANNUAL NEED	5-YEAR NEED	AVERAGE ANNUAL NEED
Professional				
Engineer	400	80	1,900	380
Scientist	400	80	1,900	380
[Subtotal]	800	160	3,800	760
Operator	-	-	-	-
Technician	200	40	1,000	200
Other				
Maintenance	-	-	-	-
Related Blue Collar	-	-	-	-
Administrative	900	180	-	-
[Subtotal]	900	180	-	-
TOTAL	1,900	380	4,800	960

8. Summary of Future Water Quality Manpower and Training Needs

As illustrated in Exhibits II-17 and II-18, which present composite estimates of current and future manpower needs by occupational category for all sectors, total water quality manpower requirements are projected to rise by FY 1976 to more than 170 percent of FY 1971 levels. Comparable increases will be experienced in all job categories, with the greatest numbers of people to be needed in the Operator and Other categories, assuming that current technology and management concepts remain the same. Exhibit II-19 portrays graphically the wastewater manpower mix anticipated for the period.

There are, however, several factors which might affect both the occupational mix and the skill requirements that will characterize the expanded wastewater work force. The following subsections of this part of the report discuss the factors likely to modify the manpower and training needs during the five-year projection period, comment upon the manpower and training needs that appear to exist for that period, and identify the apparent focal point for future manpower development efforts in water pollution control.

a. Factors Likely to Modify Manpower and Training Projections. The most significant factors which should be considered in interpreting future manpower and training needs include:

- Rapidly developing technological advances.
- Tendencies to build larger treatment facilities.
- Initiation of regional and basin planning for water pollution control.
- Requirement for increased reliability in treatment plant operations.

Technological developments have affected all sectors and all occupational categories markedly in recent years and will continue to do so through the FY 1976 projection period. In the industrial component of the nongovernment sector, for example, new manufacturing processes and techniques will pose numerous highly specialized wastewater treatment problems to complicate the already difficult problem of analyzing and treating industrial pollutants. It is possible that those responsible for the control and treatment of industrial wastewater will be forced to advance the state of the art in order to respond to governmental water quality standards and to public pressures for a clean environment. The technology of industrial wastewater treatment could therefore change very rapidly and drastically and could present the most dynamic manpower and training challenge.

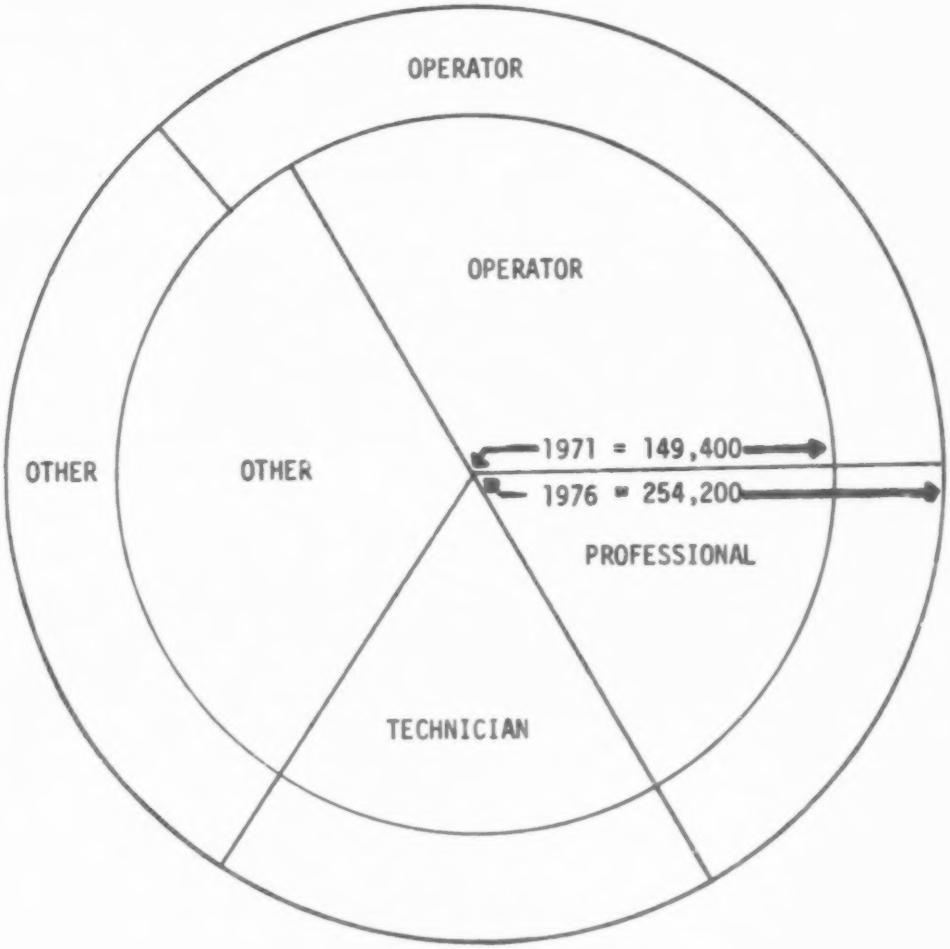
EXHIBIT II-17
TOTAL FY 1971 MANPOWER ENGAGED IN WATER QUALITY ACTIVITIES

OCCUPATIONAL CATEGORY	NON-GOVERNMENT	LOCAL	STATE	FEDERAL (NON-EPA)	EPA	TOTAL
Professional	13,200	4,300	2,100	4,600	1,200	25,400
Operator	15,400	29,700	-	4,200	-	49,300
Technician	20,500	4,000	300	1,800	300	26,900
Other	4,700	38,700	1,200	1,900	1,300	47,800
TOTAL	53,800	76,700	3,600	12,500	2,800	149,400

EXHIBIT II-18
TOTAL PROJECTED FY 1976 MANPOWER ENGAGED IN WATER QUALITY ACTIVITIES

OCCUPATIONAL CATEGORY	NON-GOVERNMENT	LOCAL	STATE	FEDERAL (NON-EPA)	EPA	TOTAL
Professional	23,400	5,600	5,500	5,900	1,800	42,200
Operator	48,700	38,600	-	5,600	-	92,900
Technician	38,900	5,200	700	2,000	500	47,300
Other	15,100	50,400	2,100	2,300	1,900	71,800
TOTAL	126,100	99,800	8,300	15,800	4,200	254,200

EXHIBIT II-19
THE MANPOWER MIX
FY 1971 and 1976



At the local government level, automation of plants and/or more widespread instrumentation of sewer collection systems could significantly change the role of the operator from that of performing certain activities to one of monitoring a number of mechanical, electronic, and information processing activities. The design of technological advances into new facilities may cause a more rapid increase in the numbers of operators and maintenance craftsmen required and a less rapid increase in unskilled labor. A heavier complement of electronics and computer technicians will be needed, as well as a larger investment in repair equipment and preventive maintenance for increasingly sophisticated instrumentation. In addition, more extensive use of automated chemical analysis equipment will facilitate control of plant operations, requiring more specialized and sophisticated technicians in the areas of chemical analysis and instrumentation. It is also inevitable that the upgrading of plants to secondary and tertiary treatment levels will increase operator specialization and, thus, training requirements. Finally, demands for increased reliability in wastewater treatment may require round-the-clock operations, substantially increasing the demand for trained personnel.

Developments in surveillance technology could affect State-level operations by introducing automated sampling and chemical analysis, altering the nature of the surveillance/enforcement function. Concurrent upgrading of skill levels of personnel at the State levels would be required to introduce specialists in electronics, statistical sampling procedures, remote reading, instrumentation, and so on. State personnel would need an increasingly sophisticated background against which to assess and monitor the increasingly sophisticated operations of wastewater treatment facilities.

The Environmental Protection Agency itself may become more involved in the management aspects of wastewater treatment plant operations at the local level and the operations of surveillance programs by State agencies because it is a central source of information on activities in all of the municipalities and states. The agency will be in a position to develop increasingly sophisticated management concepts and to disseminate them, both through direct training and through the information channels of the water quality manpower planning system.

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The ultimate effect of technological development on the future manpower requirements in wastewater treatment will be an increase in technical specialization and an upgrading of entry requirements in all sectors and all occupational categories. In turn, this will undoubtedly increase training requirements. It is also possible that new functions or job categories will emerge and that new principles of manpower utilization will affect the manpower mix in as yet undefined ways.

As wastewater treatment plant construction increases, economies in capital investment and operations will be sought through increases in the size of treatment facilities. The immediate impacts of such a tendency will be an increase in the number of personnel employed in large plants, increased specialization of workers (especially operators and technicians), and vastly more complicated management problems with regard to preventive maintenance, determination of staffing needs, manpower utilization, standards determination, and so on.

Regional and basin planning concepts are just beginning to be implemented, with full EPA support and encouragement. Such new management and planning concepts involve the creation of agencies which may conduct both planning and surveillance on an interstate basis. Although these concepts will not involve large numbers of people, they will probably require a heavier component of professional personnel and may require coordination with land use planners, forestry administrators, agricultural specialists, housing developers, zoning authorities, and so on. Regional and basin planning will rely upon interdisciplinary cooperation to further the accomplishment of Federal water quality standards.

It is likely that public demands will require more reliability in the treatment of wastewater. Currently sewage bypasses caused by plant downtime are a major contributor to the fouling of watercourses. One way to improve reliability is to schedule around-the-clock operation of treatment plants. If significant numbers of plants adopt this policy, it will result in a substantial increase in the requirement for manpower and training.

In addition to these four major factors which impact upon any numerical projections of manpower and training requirements, a number of other influences will affect future growth, including:

--Future policy decisions regarding enforcement of water quality standards on both industry and public facilities. If more stringent legislative standards are enacted, it would increase industrial water quality manpower requirements and create a more severe training need in both the local and industrial sectors. In addition, increased numbers of trained surveillance and enforcement personnel would be needed in each State or basin area.

--Levels of appropriations made available for construction of municipal wastewater treatment facilities. Needless to say, if the rate of capital investment in wastewater processing were to decrease, water quality manpower requirements would decrease accordingly.

--Economic incentives for private industry to control water pollution. Again, if such incentives are provided (over and above the compulsory surveillance and enforcement pressures), industrial water pollution control manpower requirements could be expected to rise, and industry might be expected to contribute significantly to the effort to develop means of treating its waste products.

--Levels of appropriations for Federal and State regulatory and technical assistance staffs. Clearly, if the decision is made to enforce water quality standards but no funding is available for regulatory staff personnel or for provision of technical assistance to those municipalities or industries striving to comply, the momentum of facility construction and methods development will lag.

--Ability of the construction industry to respond to higher demands for treatment facilities.

Although it is not possible at this time to determine the quantitative impact of these factors, many of which are of uncertain probability, on the preliminary manpower and training projections provided above, they must be considered in identifying probable future manpower and training gaps. Further, it is reasonable to expect that these factors will have substantial effects on the manpower utilization and employment practices and patterns of practically all water pollution control employers. As these factors become manifest to the employers and employers obtain a better view of what is to be done and how it is to be done, they will undoubtedly be acting to:

--Change recruiting practices.

--Change employment qualifications.

--Modify employee mix.

--Modify training requirements.

b. Manpower and Training Problems in Various Occupational Categories. In light of the previous discussion, on the basis of a projection of current trends regarding training needs--as portrayed in Exhibit II-20 at the end of this subsection--and in consideration of the most probable future developments in wastewater technology, management, funding, and administration, a number of manpower and training problems appear to exist. They are discussed below in terms of the manpower supply and demand and the depth of required training.

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EXHIBIT II-20
TOTAL ESTIMATED FY 1972-1976 ENTRY AND UPDATE WATER QUALITY TRAINING REQUIREMENTS

A. Entry Training

OCCUPATIONAL CATEGORY	AVERAGE ANNUAL LOAD					
	NON-GOVERNMENT	LOCAL	STATE	FEDERAL (NON-EPA)	EPA	TOTAL
Professional	2,960	500	880	520	160	5,020
Operator	8,260	3,480	-	520	-	12,260
Technician	5,160	480	100	140	40	5,920
Other	2,580	400	-	60	180	3,220
TOTAL	18,960	4,860	980	1,240	380	26,420

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EXHIBIT II-20 (Cont'd)

B. Update Training

OCCUPATIONAL CATEGORY	AVERAGE ANNUAL LOAD					
	NON-GOVERNMENT	LOCAL	STATE	FEDERAL (NON-EPA)	EPA	TOTAL
Professional	9,140	2,480	1,920	2,640	760	16,940
Operator	16,020	17,080	-	2,460	-	35,560
Technician	14,860	2,300	260	960	200	18,580
Other	3,280	1,260	-	280	-	4,820
TOTAL	43,300	23,120	2,180	6,340	960	75,900

(i) Professionals

The professional category includes personnel with both engineering and scientific backgrounds. In water pollution control, the professionals' professional is the sanitary engineer. EPA believes that many of the new professional positions can best be filled by sanitary engineers, particularly in view of the increasing technological sophistication of water pollution control. Therefore, the supply should be increased.

At the same time, EPA recognizes that many new professional positions will be filled by those trained in disciplines other than sanitary engineering. Likewise, many existing positions will continue to be filled by those trained in other disciplines. This points up the desirability of planning and delivering update and upgrade training for these professionals as well. For those already in the water pollution field, this would be training to broaden and sharpen their skills. For those initially entering the water pollution field, this would be speciazlized water pollution training which, when added to their basic engineering or scientific skills, would enable them to function effectively and efficiently in water pollution occupations.

Many engineers and scientists in water pollution control function as administrators as well as technical specialists. Currently very few engineers and scientists exist who are knowledgeable and experienced in the field of wastewater equipment maintenance management, community relations, negotiation of industrial wastewater processes and charges, and management of a highly varied and uniquely skilled manpower population, all of which are required at the management level. Specific training will be required to provide these skills and build the managerial confidence and competence necessary to deal creatively with the problems of an ever-changing operational environment.

(ii) Operators

As stated in Section A of this part of the report, experienced operators are rarely available on the job market, largely because of the unique and specialized nature of their responsibilities. Few of the skills have counterparts in other segments of our economic system, yet the job is critical to any effort to attain satisfactory treatment of wastewater. The current supply of trained operators is barely adequate for current operations, and the only manpower pool is currently employed in the wastewater field. Therefore, the future supply of operators must be created at a faster rate than the demand is growing in order to simultaneously meet past deficiencies, and satisfy future needs and account for turnover. Large quantities of update as well as entry training are required. Operators represent a serious problem, both in terms of manpower and training requirements.

(iii) Technicians

An increasing number of technical positions in the wastewater field will require personnel with associate or bachelor of science degrees, often with specialization in laboratory analysis, computer applications, or electronic systems. The projected high demand for various technicans in the projection period may become more urgent as technological developments increase the sophistication of sewage collection and wastewater processing systems. Further, the growing specialization of wastewater treatment processes is increasing the proportion of technicians of various types of professionals (engineers and scientists) as facilities attempt to reduce their manpower needs by improving manpower utilization. A substantial amount of update training is also required.

(iv) Other Categories

Among the "Other" categories, the maintenance function probably presents the biggest problem. Although there is a significant supply of skilled craftsmen whose skills might be directly applicable to wastewater maintenance problems, future manpower projections indicate a rapidly growing need for more specialized and higher skilled maintenance personnel as a greater number of larger, more sophisticated wastewater treatment facilities are constructed and begin operations. The critical need for improved maintenance in municipal treatment plants was highlighted in a 1970 Report of the Comptroller General to Congress and will become even more pressing in future years. Although update training requirements for maintenance personnel may not occur as frequently as for other occupational categories, wastewater employers may face some difficulties in recruiting and providing entry training to a sufficient number of such craftsmen to meet the need that is anticipated between now and FY 1976.

Because no specialized water quality training is required to perform administrative and clerical functions in a water pollution control agency, there appears to be neither a supply/demand imbalance nor an anticipated training gap in the five-year projection period. Similarly, there are generally no educational or experience requirements for related blue-collar workers and no specialized training is required, so there appears to be neither a supply/demand imbalance nor an anticipated training gap for this group in the five-year projection period.

c. Focal Point for Future Manpower Development Efforts in Water Pollution Control. Clearly, on the basis of Exhibits II-18, II-19, and II-20, and the previous discussion, the greatest manpower need in terms of quantity will be in the operator and technician categories and the greatest training need will affect operators, technicians, and engineers. At the same time, the most rapid manpower growth is projected to occur in the local and nongovernment sectors. These projections indicate that the fastest growing activities will be plant construction/operation/maintenance in municipalities and industrial firms, accompanied by an increase (although less rapid) in State planning/surveillance/monitoring of installation and operations and EPA grant administration and technical assistance related to operations. Undoubtedly, the bulk of the training will be operator-oriented. However, just as critical, if smaller in quantity of workers affected, is the need to produce additional sanitary engineers. Of equally critical nature is the need to update present professionals and to provide specialized water pollution training to professionals entering the field with a basic engineering or scientific background but without adequate preparation in water pollution control.

E. Conclusions Regarding Planning for Manpower and Training Needs

The goals of the water pollution manpower development system are:

(i) To have manpower available in the needed numbers, with the requisite skills, at the proper times and proper places.

(ii) To use available manpower effectively and efficiently.

Because of the magnitude and complexities of the industry, a carefully designed manpower planning system is necessary to meet these goals. Such a system has been conceived and partially implemented by EPA. It is an intergovernmental and interagency system and includes both public and private employers, with the states being pivotal. Basically the system consists of two components:

- Forecasting (as authorized by subsection 5(g)(2) of the Water Pollution Control Act).
- Action Planning.

When in full operation, the forecasting component will project water pollution control manpower requirements and entry, update, and upgrade training needs by occupation on a national, State, and labor market basis. Presently, as the system conceptualizer and coordinator, EPA is well along in the process of developing the tools and base data for the waste treatment plant portion of the system. EPA has also recently begun preparing for training of the personnel who will implement the system.

The action planning portion of the system produces a variety of action plans at all levels. These are plans to fulfill the manpower and training requirements in accordance with the forecasts and to ensure effective manpower recruitment, retention, utilization, and personal satisfaction. Action plans are of two basic types:

- Plans for recruitment, retention, and utilization programs.
- Plans for training programs.

EPA provides technical assistance to others in action planning in addition to developing its own action plans to fill in the gaps left after actions planned by others are accounted for.

The planning program development to date has been accomplished on a very limited budget; many of the efforts to date have been awkward because they had to be "piggybacked" onto other DOL and EPA programs. However, since the program is now conceptualized and the basic tools are in process, the program can soon be installed in the field. Manpower planning is a new function for most State and local governments, and these units presently have a very limited capacity to conduct such planning. Full implementation will require a higher level of expenditure since the states and localities will require substantial technical assistance and training to accomplish their planning responsibilities. This requirement for additional technical assistance is reflected in the EPA FY 1972 budget.

Pending the completion of the implementation of the water pollution control manpower planning system, EPA has developed by means of a variety of techniques an interim estimate of the current manpower inventory and five-year sector-by-sector forecasts of manpower and training needs for the major manpower categories (professional, technical, operator, and others).

These forecasts are based on data that are subject to a number of qualifications. However, EPA places high confidence in these figures as indicators of the order of magnitude of manpower and training needs.

Forecasts indicate that the needs for additional professionals over the next five years will be about--25,000 entry positions over five years. This indicates a need for the universities to continue to produce these professionals. These professionals fall into two broad categories: sanitary engineers who are trained as water pollution control specialists and other professionals who have basic scientific and engineering skills but require additional specialized water pollution control training to function effectively in the field.

Experts in the field point to a need for increasing the portion of sanitary engineers, thus pointing up the need for increased production of this group. There is also a critical need for the specialized water pollution control training necessary to make fully effective producers of the general group of professionals. In addition, there is an estimated need for technical update training--17,000 trainees being the estimated annual load over the five-year period. Further, there is a need for management training for those many professionals who have assumed administrative duties in addition to their technical responsibilities, but who have never received training in the sophisticated management techniques they must apply.

The requirement for new technicians is moderate, approximately 30,000 new entry-level positions in five years. However, due to the increasing technological complexity of the field, there is a general requirement to upgrade the formal educational background of the technicians. More and more technicians will be requiring at least one year, and many two years, of college level preparation. Further, particularly for those technicians already on the job but undereducated, there will be a need for update training, 18,500 trainees being the estimated average annual load.

Perhaps the most critical need is for additional operators and operator training. As has been pointed out by EPA, the General Accounting Office and others who have examined the situation, undermanned plants and undertrained manpower are a major jeopardy to the entire control program and the large capital investment that has been made in facilities. In the next five years, it is estimated that 41,000 entry-level positions in private industry and 20,000 in public agencies will need filling. There are almost no trained but unemployed operators so that essentially the entire requirement must be produced from scratch. Likewise, the need for update training of the existing force is estimated at 35,560 - average annual need over the next five-year period.

PART III
MANPOWER RECRUITMENT, RETENTION, AND UTILIZATION ACTIVITIES

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PART III
MANPOWER RECRUITMENT, RETENTION, AND UTILIZATION ACTIVITIES

A. Introduction

Gross manpower and training requirements can be partially fulfilled through activities designed to improve effectiveness and efficiency of the existing labor force, as well as through activities designed to train additional members of that force. EPA considers that such activities will make a significant contribution to the achievement of water pollution control manpower objectives: the availability of personally satisfied and properly utilized manpower in the needed amounts, with the requisite skills, at the proper times and in the proper places. Accordingly, EPA has undertaken a number of activities in this area. For reporting purposes these activities are broken down into three categories:

- Manpower Recruitment.
- Manpower Retention.
- Manpower Utilization.

A discussion of each of these categories follows. Some of the activities may have ramifications under two or even three of the categories. However, below they are discussed under the category of their primary thrust.

B. Manpower Recruitment Activities

The primary responsibility for recruitment rests upon the estimated 25,000 independent water pollution control employers scattered throughout the country. Accordingly, there is no necessary assurance, especially during a labor sellers' market caused by rapid expansion of the industry, that these employers will have an adequate supply of interested and basically qualified manpower from which to recruit. The existence of such a supply is fundamental to adequately staffed operations and, therefore, at least in part, to efficient and effective water pollution control. Further, without such a supply, recruiting standards tend to be forced below the reasonable minimum, thereby increasing training requirements.

Therefore, EPA has taken actions, largely as a delegate of the Department of Labor, to increase the size of the pool by development and widespread dissemination of information regarding careers in water pollution control, as discussed below.

1. "Talent Search"--A Movie

EPA has produced and now distributes a 16 mm color-sound movie depicting the work, training, and importance of wastewater treatment plant operators. The purposes of "Talent Search" are:

- To encourage people, particularly young people, to enter the wastewater treatment field.
- To dispel erroneous ideas held by many persons about the work of the wastewater treatment plant operators.
- To enhance the self-image of the operators, thus helping them to take pride in and appreciate the importance of their jobs.

This movie, which won a top award from the National Visual Communications Association, has been shown to numerous groups of high school students, unemployed workers, placement groups, and environmental organizations. A Spanish language version of the movie is being used to reach Puerto Rican, Cuban, and Mexican American audiences where Spanish is the first language in the home. Recently, prints of "Talent Search" have been released for showings in Latin American countries, and in Mexico, the movie has been shown on nationwide television.

2. Recruitment Brochures

EPA has developed and now distributes recruitment brochures in both English and Spanish that summarize the challenges, tasks, opportunities, and rewards that are offered by employment in the wastewater treatment field. EPA also distributes an attractive descriptive recruitment

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brochure published jointly by the Texas Water Utilities Association and the Texas Water Pollution Control Association. This brochure--entitled, "Water . . . the Growth Industry; What's in It for You?"--stresses the importance of water to human habitation, the pay, job security training, and the intangible feeling of rendering needed services, all of which flow from a career in water.

3. Articles and Reprints

From time to time, EPA staff members prepare articles for publication in general circulation periodicals related to the need for wastewater treatment manpower. A recent example is an article entitled, "A Critical Need--Training for Wastewater Treatment Plant Operators." As the title implies, the article sets forth the need for operators and then proceeds to discuss present training programs.

EPA also obtains and distributes reprints of articles applicable to waste treatment manpower recruitment. For example, recently reprinted and distributed was an article from the Occupational Outlook Handbook and Quarterly entitled, "Training, Upgrading, Reinforcing Water Pollution Control Workers."

4. Veterans Recruitment

Recognizing that recent veterans are a very important recruitment source, EPA has established a mail-order recruitment and referral system for new veterans and servicemen pending discharge. The principal components of this system are various types of outreach information concerning careers in wastewater treatment and--in answer to specific inquiries from veterans or "short-timer" servicemen--the provision of specific information identifying wastewater treatment employers offering job and/or training opportunities throughout the country.

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C. Manpower Retention Activities

Once satisfactory personnel have been recruited, the next concern is the retention of these newcomers so that the recruitment and training investments they represent will not be wasted. A high turnover rate portends inefficient and ineffective operation and a continual demand for more recruits and more training. Conversely, improvements in retention rates will reduce manpower and training demands. As with recruitment, retention is the primary responsiblity of the employers. However, since retention affects the attainment of national water pollution control goals, EPA takes an active interest in the subject.

To date, the primary EPA focus on retention rates in water pollution control has been on operators. As was noted in Part II, retention rates for operators have been quite low, particularly in the first year of employment. This has caused general concern among water pollution control managers.

The basic prerequisites for high retention of productive employees are several. Among the primary ones are:

--Good working conditions.

--Good job image.

--Good pay.

--Opportunity for advancement.

The operators' working conditions are not the most pleasant, by the nature of the job, and the operator's job is not held in high esteem or appreciation by his community. In a recent study of operator trainees conducted for EPA[1] only 4 percent expressed complete satisfaction with public appreciation of their work. Fifty-two percent were generally not satisfied, and 19 percent were completely unsatisfied. Confirmation of this problem regarding operator image comes from another finding in this same study. The trainees were asked which job title they preferred for their occupation as operator:

(i) Sewage Treatment Plant Operator

(ii) Wastewater Treatment Plant Operator

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[1] Sewage Treaters or Pollution Controllers--Trainees View Their Jobs, Environmental Protection Agency, Office of Water Program, Division of Manpower and Training, by Longino, Green and Kauffman.

(iii) Waste Treatment Plant Operator

(iv) Water Pollution Control Specialist

Most often, the trainees chose the last named.

While no hard data are available,[1] pay rates for operators are generally acknowledged, by those familiar with the industry, to range from very low to very high, but on the average to be at most no more than barely adequate. Further, while there have been opportunities for career advancement of operators, they have not been overwhelming.

One possible way to positively effect all of these retention factors and also improve manpower utilization is through operator certification. It is necessary to understand the background and current status of certification in order to appreciate its full significance and to understand EPA activities in this regard.

Interest in certification of operators has been growing among the states in the hopes that ensuring minimum personnel qualifications will improve the operational effectiveness of wastewater treatment facilities. The President supported this trend in his 10 February 1970 Message to Congress, in which he announced a policy that will require future Federally assisted treatment plants to be operated only by State-certified operators. Further, the President has issued Executive Order 11507 which requires operators of Federal waste treatment plants to be certified in accordance with the requirements of the state in which the plant is located.

Currently 47 of the states require some form of operator certification, and in 31 certification is mandatory. Yet considerable variation exists among the states in educational prerequisites, experience requirements, duration of certification, and applicability of the program. The term "State-certified" on an operator's resume does not have a uniform meaning.

Formal education of some kind is required by 62 percent of the certification programs, but even this requirement varies among the states from eighth grade level to completion of a four-year college program. In addition, 84 percent of the states permit experience to be credited instead of education and a number credit special training, weakening the effectiveness of the educational parameter to determine the quality of the work force. Experience requirements are equally varied, with different states requiring from one to 12 years of experience for the highest class of operators and from three months to four years for the lowest level. Further, many states do not require a written examination as a certification requirement; 15 percent use an oral examination, and four states require only a statement of qualifications--and no examination of any kind.

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[1] Wage data for treatment plant personnel will be available upon completion of the EPA/DOL survey now under way. This survey is discussed in subsection II-B-1-b-(2), above.

Variations in the duration of certification also confuse the State certification picture. While a majority of the states require annual renewal, a number have renewal periods as long as five years, and even more issue permanent certification. Unfortunately, these states cannot have meaningful visibility over the skills of their operational personnel.

Applicability of certification varies among the states, both in the categories of wastewater treatment manpower who may be certified and in the extent to which mandatory certification is being achieved in those states where it is required. Some programs certify only wastewater treatment plant personnel, but others will certify employees concerned with collection systems. Only seven of the mandatory certification programs are known to apply solely to treatment facilities. The waiver of examinations and required training and education under "grandfather clauses" for operators employed before certification was instituted tends to defeat the purpose of certification in a number of states. Under such provisions, untrained workers are sometimes allowed to operate plants; in one state with a mandatory certification program, 380 of the 391 certified plant operators were qualified under the grandfather clause.

Classification systems for certified operators include from two to 11 categories, and many states do not specify limitations on the type of facility to which a worker's certification is applicable. In fact, in more than 19 states, approved certification will allow an operator to operate any type of wastewater treatment process. Finally, a Water Pollution Control Federation survey reported in 1970[1] indicated that of all the wastewater facilities identified as requiring certified operators in 12 selected states which have mandatory certification programs, only 80 percent were being staffed by certified personnel--regardless of the adequacy of the requirements under which they were certified.

Sound operator certification standards can benefit operators, employers, and the public. The assurance that wastewater treatment plant operators are competent reduces the need for strict surveillance of plants that is otherwise required of the responsible State agency. Further, an effective certification program can be productive to prevent and reduce pollution. Employers benefit through the protection of their capital investment, resulting in maximum plant utilization and reduced repair and maintenance expenses. Finally, employees benefit from salary increases, increased status and responsiblity, improved job security, and increased opportunity for career advancement.

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[1] WPCF Personnel Advancement Committee, "Survey of Wastewater Treatment Plant Operator Certification in the U.S.," Water Pollution Control Federation Journal, Vol. 42, No. 4, April 1970, p. 516.

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The Water Pollution Control Federation and the American Water Works Association have recently addressed themselves to the problems of certification and have made significant contributions toward their resolution. EPA views these efforts with favor. Yet, if State certification is to be meaningful, practices must be standardized and training opportunities proliferated, for more stringent certification requirements will greatly inflate the size and complexity of the operator training problem. Such an effort on a nationwide effort will require the resources of the Environmental Protection Agency.

EPA believes strongly that states should establish mandatory uniform certification laws based on national criteria. To meet this objective EPA is providing technical and financial support to the Water Pollution Control Federation, the American Waterworks Association and other interested organizations to establish a national certification board. This board will serve as an information center for certification activities, recommend standards and guidelines, facilitate reciprocity between State programs and assist authorities to establish and update programs. To facilitate states adoption of national certification programs based on national criteria, technical assistance and training should be provided by EPA.

There will be difficulty in establishing uniform criteria for certification because of the variations in present practices. Further, at present there is not a sufficient understanding of the operational tasks performed in the industry as a whole. Since certification criteria must be directly related to the tasks operators perform, uncertainty about tasks means uncertainty about criteria. The studies under way to develop planning tools [discussed in subsection B-1-b-(1) of Part II] will also yield task information. Additional studies will likely be required. Also, it will be necessary to solicit the views of the states and other interested parties in the process of developing the national certification criteria.

As a prelude to State adoption of a program based on the national certification criteria, it will be necessary for the states, with technical and financial assistance from EPA, to design transition programs which will take into account the additional training and other effects which will flow from the new certification requirements. To design, establish, and subsequently operate these certification programs, the states will be called upon to take new administrative and legislative tacks.

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D. Manpower Utilization Activities

More productive use of available manpower will also lead to a reduction in gross manpower requirements, and hence, in training requirements. In this respect, perhaps the most attention has been devoted to manpower utilization as one important portion of the proper operation and maintenance of treatment plants. Here, once again, the employer is basically responsible for optimum manpower utilization. However, because of the national interest in the protection of Federal investment in new facilities, EPA has taken direct actions to ensure proper operation and maintenance. This includes the following actions to assure appropriate manpower utilization.

In response to a recommendation of the Comptroller General, EPA has issued a document, "Federal Guidelines, Design, Operation, and Maintenance of Wastewater Treatment Facilities." The guidelines require applicants for facility construction grants to include in their applications a list of the numbers and types of personnel needed to operate and maintain the proposed plant. This list must be updated at the completion of 50 percent of the construction. Thirty days prior to plant start-up, another update must be reported to the cognizant State agency. Further, the guidelines require that the chief operator must be employed by the time construction is 50 percent complete in order to ensure his full familiarity with the plant. Finally, the guidelines require the designer to consider manpower utilization factors in design and to furnish an operations manual to the owner which sets forth operation and maintenance requirements and procedures.

To provide designers with basic data and concepts for use in development of operation and maintenance manuals, EPA has also let a contract to develop improved concepts and methods by which (i) wastewater treatment plant designers can better reflect operation and maintenance considerations and (ii) managers can more realistically determine staffing requirements and establish effective maintenance management programs. The basic principle in this effort is the application of the techniques developed for analyzing the operation, maintenance, and reliability of complex naval propulsion systems to wastewater treatment plants. Sewage treatment processes are being broken down into subgroups for detailed analysis, and special attention is being devoted to operations, maintenance, staffing, and quality assurance. Upon completion, this project is expected to produce a model for determining the classification and skill levels required of operation and maintenance personnel and recommendations regarding alternative staffing concepts. It is expected that this work will provide a base for future work by the Environmental Protection Agency in the application of advanced industrial engineering and maintenance management techniques in the wastewater treatment field.

Once new plants become operational, evaluation of their performance becomes the responsibility of the cognizant State agency.

However, EPA is presently considering the establishment of a Federal audit, to include the manpower aspects of plant operation, one year after operations have commenced. Meanwhile, EPA has let a contract for the development of a manual to be used to train State inspectors. The contract also calls for the development of a training plan for inspector training, and it is anticipated that such a course will be developed and offered in the near future.

EPA has approached improvement in manpower utilization through one other channel. As an adjunct to its Public Service Careers (PSC) training program (discussed more fully in Part IV of this report), EPA has been using Department of Labor funds to provide financial and technical assistance to PSC subcontractors for job restructuring. The concept of job restructuring calls for a task analysis of jobs for the purpose of rearranging and recombining tasks in packages that require skills of similar rather than mixed levels. For example, many jobs are presently made up of tasks requiring a mixture of professional, paraprofessional, and even lower level skills. Since some of these tasks are professional, professional level persons must fill these jobs. To the extent that professional employees are required to perform paraprofessional and lower level tasks, there is a gross underutilization of manpower. In restructuring a job, the objective is to rearrange the tasks so that to the maximum feasible extent, professionals do work requiring professional skills, paraprofessionals do work requiring paraprofessional skills, and so forth. The result of a productive restructuring should be the accomplishment of the tasks at the most economical level of labor and training costs.

Also, since the more homogeneous stratification of tasks means that the proportion of jobs at the lower end of the skill spectrum will increase, more of the jobs can be filled by workers of lesser qualification, broadening the recruitment base. Further, many of the additional potential recruits would be the disadvantaged.

E. Summary and Conclusions

It is possible to reduce water pollution control manpower and training requirements through the application of manpower recruitment, retention, and utilization techniques. While the application of these techniques is in the first instance the responsibility of the employers, their application or lack thereof also bears directly upon the success of the Federal water pollution control program. Therefore, EPA has taken a number of actions to further their adoption.

Most of these actions have been undertaken as an agent of the Department of Labor or as an adjunct to the construction grants program. Taken together, they only scratch the surface of the activities that could be undertaken by EPA to provide management assistance and/or training to employees in the application of such techniques. Further, taken together, they probably only begin to reap the benefits in terms of reductions in manpower and training requirements that could be obtained by the systematic and widespread application of such techniques by all water pollution control employers.

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PART IV
TRAINING ACTIVITIES

A. The Environmental Education Process

The concern of the Federal Government for environmental education was manifested in the congressional enactment of the Environmental Education Act of 1970. This act (P.L. 91-516) authorized the U.S. Commissioner of Education to make grants to establish educational programs intended to encourage public understanding of policies and activities in support of environmental quality. In FY 1971, the Office of Environmental Education of the Office of Education, Department of Health, Education, and Welfare, awarded 74 grants totaling $1.7 million for projects in 31 states and the District of Columbia. The grants support several types of education projects, including community education, curriculum development, establishment of environmental education centers, training of public employees other than teachers, and dissemination of information to the public.

Because people at various ages and stages of life need different kinds and degrees of environmental information, an EPA Task Force on Environmental Education is currently considering the specific role EPA should play in general environmental education and how it should interface with other concerned agencies. EPA's current programs include a variety of technical training grants to promote public interest and knowledge. For example, one such grant was made to the Tilton School (Tilton, New Hampshire) to develop a curriculum guide and teaching materials designed to introduce water pollution control illustrations and examples into general science and biology courses in secondary schools. These materials encourage active participation of both teachers and students in solving environmental problems. The project, involving 40 schools throughout the northeast, is a follow-on to a program EPA supported at the University of Massachusetts during the summer of 1969 and a program which the Ford Foundation initiated during the same period at the Tilton School. Negotiations are currently under way to accelerate the distribution, acceptance, and use of the Tilton program on a nationwide basis.

Other representative grants awarded by EPA for general education/awareness purposes include one to the District of Columbia League of Women Voters Education Fund to develop schools for citizens on water use, an award to the Washington (D.C.) Ecology Center to promote environmental education and awareness for youth, and a grant to the Institute of Environmental Education (Cleveland Heights, Ohio) to develop a national program in environmental education.

EPA also sponsors SPARE, which began operations in 1971, is funded by the Department of Labor (as an offshoot of the Neighborhood Youth Corps Program) and is operated by EPA. Since its inception, SPARE has provided a combination of jobs and prevocational environmentaal training for approximately 9,000 low-income youths, ages 14 to 20, in 50 communities across the country. Typical of these projects was one involving 11 high school students in Coos Bay, Oregon. With the necessary supervision and counseling, the students executed a carefully conceived series of dye flow tests to trace the source of sewage badly fouling Coos Bay to 29 residences not tied into the sanitary sewer system and, more important, to two breaks in the sanitary sewer line. Action has been taken to remedy these defects as a result of the students' finds and the enthusiastic support of city officials and citizens.

These are only a few examples of EPA's efforts to cooperate with all interested parties in promoting public awareness and support for environmental programs. The balance of this part of the report relates to that portion of the environmental education process that pertains directly to jobs in the water pollution control field. Most water pollution control jobs begin with a period of intensive "entry" training related immediately to the functions of the particular job. Such training may be formal or informal, or a combination, and may be classroom-oriented, on-the-job training, or a combination. As the career of the water pollution control employee progresses, he will almost inevitably need additional training, usually of a highly specialized nature and of relatively short duration, either to "update" his skills to keep current with technology or to "upgrade" them to permit career advancement.

Section B, below, describes the activities of those non-EPA agencies concerned with water quality by sector--nongovernmental, local government, State government, and non-EPA Federal Government. It also assesses those activities in terms of the agencies' roles in water pollution control training and the adequacy of their activities to satisfy the most compelling current training needs--by occupational category (professional, operator, and technician, as established in Part II) and type of training (entry or update/upgrade). Conclusions are presented regarding the extent to which the needs identified in Part II of this report are being satisfied by the activities of these employers.

Section C describes the efforts of the Environmental Protection Agency to address those needs left unsatisfied by other water quality employers and to fulfill its role as a focal point for water pollution control manpower and development information and activities.[1] The EPA program is discussed in terms of the two most general categories of training recipients--professionals and operators/technicians. Each of the agency's major programs for these categories is described and assessed against the unresolved need, and conclusions are drawn regarding the past adequacy of the programs and the future support needed to meet an ever-expanding training need.

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[1] In order to present a complete and comprehensive picture of EPA training activities in response to identified needs, this part of the report describes both those activities for which Congress has requested a report [subsection 5 (g)] and those supplementary activities authorized elsewhere in the Federal Water Pollution Control Act.

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B. Non-EPA Water Pollution Control Training Activities

1. A Frame of Reference for Roles in Training the Manpower for Water Pollution Control

To initiate a manpower training program, two intangibles must exist: a need for the training and a motivational commitment on the part of the beneficiaries of water pollution control services to satisfy that need. The need for water pollution control training at all occupational skill levels is well recognized (and documented in Part II of this report). A commitment among interested parties in all sectors to establish that training, or to improve and expand that which exists, and to use the training, is long-standing.

Commitment connotes action, however, and action requires three types of tangible resources:

- The capacity to train, by means of:
    - --Requisite and accessible facilities.
    - --Available and qualified instructors.
- The information with which to train, including:
    - --Tailored curricula.
    - --Effective and responsive materials.
- The funds to enable the training to be initiated and conducted:
    - --To build the capacity.
    - --To develop the information.
    - --To bring together the provider and recipient.
    - --To present the program.

The roles of the various non-EPA agents in water pollution control training are defined by the resources which they contribute to the training "action." Those who provide the capacity to train may be said to play a direct role in training because they are the primary points of contact with the trainee. Those who develop course information or provide enabling funds are engaged in a more supportive role. Some organizations play a catalytic role in encouraging the direct or supportive activities of others. Roles are rarely distinctive and are frequently interdependent. However, predominant orientations can be ascribed to the primary participants in the training process.

Educational institutions generally have the capacity and develop or possess the information to provide for the basic educational requirements of their students for entry into occupational fields at various

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levels. Support is normally required to develop the capacity and information needed to respond to the specific vocational requirements of their students, particularly for occupations, such as water pollution control, whose missions or skill shortages require extraordinary action. Stimulation from others is frequently required, especially financial assistance (through grants or fellowships) to supplement normal sources of funds.

Associations, whose memberships frequently include academicians and employer representatives, assume a catalytic role in encouraging, helping organize, and cosponsoring programs. When voids exist, they sometimes provide the capacity or information or the financial support for others to do so.

Employers of manpower hold primary responsibility for orienting each entrant to the peculiarities of his work environment and providing requisite transitional skills to ensure his adequate job performance. They also must ensure that employees maintain their proficiency within the current state of the art and that employees receive opportunities to upgrade their skills to qualify for promotion.

Private industry employers generally provide orientation and informal training on the job. Normally only the larger employers develop and present formal programs for updating and/or upgrading their employees. More typically, they rely on the resources of others to organize and present such programs.

Government agencies at the local, State, and Federal levels act in a similar capacity, but with broader purpose and, consequently, on a larger scale. Indeed, their stimulative function sometimes extends to the imposition of mandatory training requirements with which others must comply.

Local government agencies bear primary responsibility for providing adequate public wastewater treatment facilities and ensuring their effective operations. In fulfilling this responsibility, they mirror the private employer's job of recruiting, training, developing, and retaining the manpower needed. They plan and administer manpower development programs to satisfy local requirements.

State agencies establish standards, criteria, regulations, and other guidelines to promote statewide uniformity and to further objectives which transcend those of local jurisdictions. They also plan and administer manpower training programs to satisfy statewide needs and help build the capacities of their state educational institutions to assist in this effort. Their primary role is supportive, through provision of financial, technical, and planning assistance. They also provide direct services, singly or collaboratively, when others are unable to do so.

Federal agencies perform a similar role, but from a national program view point and in response to national priorities. Two distinctions are noteworthy, particularly when related to programs of national urgency. With the revenue systems of State and local governments and their educational institutions already strained in attempting to provide traditional service, the Federal Government provides the principal financial resources to stimulate or facilitate these programs (as is manifestly evident in water pollution control). Secondly, the orientation of the Federal planning financial and technical assistance is to build the capacity of others to more effectively plan, organize, administer, and deliver the requisite services.

The interrelationship of the roles of these various agents is evident--and vital--in order to build and maintain the capacity and to develop and improve the information with which to train the manpower for water pollution control. This section (IV-B) of the report describes the training activities of the non-EPA nongovernmental and governmental organizations in the exercise of their respective training roles.

2. Training Activities of Nongovernmental Organizations

Nongovernmental organizations engaged in water pollution control training include educational institutions, associations, and private industry, as discussed below.

a. Training Activities of Educational Institutions. Educational institutions orient their water pollution control training activities to degree programs for students who potentially may pursue careers in the field. These institutions may be distinguished into two groups in terms of the duration of courses of study and the occupational categories for which students are being prepared:

- Universities and four-year colleges, which concentrate their program activities on the professional, primarily at the graduate level.

- Two-year colleges and technical schools, which focus their programs on the operator and the technician.

Each of these types of educational institutions is discussed below.

(1) Training Activities of Universities and Four-Year Colleges. Many universities and four-year colleges offer degree programs in disciplines which relate indirectly to water pollution control. Within the natural sciences, the disciplines of engineering and the physical and biological sciences offer the most direct relevancy to the field of water pollution control; degrees projected[1] for these disciplines are as follows:

Degrees	1970-1971	1975-1976
Bachelor's and First-professional	102,540	119,060
Master's	34,120	43,890
Doctor's	12,530	20,840
	149,190	183,790

Few programs are oriented directly to water pollution control,[2] suggesting the need for supplementary training for those professionals recruited into the field after obtaining generalized degrees.

EPA estimates that approximately 100 universities and four-year colleges offer degree programs oriented specifically to water pollution control. The major thrust of their involvement is in providing degree programs for students at the graduate level. These institutions have been relatively inactive in independently sponsoring or conducting training other than their formal degree programs. In particular, these institutions have not played a significant role in providing special short courses or supplementary programs to update or upgrade the skills of those professionals previously recruited into the field of water pollution control.

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[1] Projections of Educational Statistics to 1970-80, National Center for Educational Statistics, 1970 Edition.

[2] See subsection IV-C-1-a for a discussion of the EPA Professional Training Grants Program.

Universities and their staffs, however, have supported the manpower training activities of non-EPA organizations in a variety of ways. Facilities have been provided, faculty members have participated as instructors, and assistance has been given to others in developing curricula and training materials.

These institutions are the primary source for preparing professionals for entry into the field of water pollution control. Through their research and instructional capacities, their potential contribution to the training of manpower already working in the field is substantial. Two noteworthy programs demonstrate the potential impact that can be made by universities, when providing support to and receiving support from other sectors. Illustrative activities of Clemson University are highlighted in this subsection; those of Texas A & M are discussed with those of the State of Texas in subsection IV-B-3-b, below.

Clemson University has conducted annually a three-day operator school since the mid-1930's. Trainees who successfully completed an end-of-course examination were granted certification by the South Carolina Water and Pollution Control Association. Passage of a mandatory certification law effective in 1968 increased course enrollment by 50 percent.

Since 1952 the General Assembly of South Carolina has appropriated $10,000 annually (increased to $20,000 in 1967) as a direct and continuing appropriation to Clemson University for the preparation and administration of correspondence courses for the operators of treatment plants in the State. Correspondence courses in the form of manuals were developed by the University faculty for both water and wastewater treatment plant operators at four levels. The manuals offer opportunity for self-education during the elapsed time between the annual operator training schools, and they are also used as preparation for the certification examination. The additional funds appropriated since 1967 were intended for revision of these manuals and the hiring of a person to visit plants and offer on-the-job advice. The revisions were accomplished with participation from university faculties in several other states to reduce sectional influence and to increase the potential for nationwide replication.

Clemson University also prepared a videotape designed to alert operators to the training opportunities available to them from the local to the national level. The tape has been presented on the South Carolina statewide educational television network as well as at State and national operator training meetings.

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The University sponsored a National Conference on Wastewater Treatment Plant Operator Training in 1969 in cooperation with the Water Pollution Control Federation and the Federal Water Pollution Control Administration. The presentations and discussions of operator training activities and needs mirrored the widespread concerns that led to the passage of the Water Quality Improvement Act of 1970 and its emphasis on operator training. Since then, Clemson University has continued its active interest in this field. Its contributions under EPA support are noted in Section III-C below.

(2) Training Activities of Two-Year Colleges and Technical Schools. A 1964 survey of technical education offerings in the nation's schools revealed only one program to educate water and wastewater technicians--a newly begun program at the Fayetteville Technical Institute in North Carolina. Under contract with the Office of Education's Vocational and Technical Education Division, the Institute produced a review draft of a curriculum guide in July 1966. Several institutions initiated programs based on that guide, the final version of which was printed in May 1969 as a joint interdepartmental publication (Office of Education and Federal Water Pollution Control Administration), entitled, Water and Wastewater Technology, A Suggested 2-Year Post-High-School Curriculum.[1]

In 1969, 17 schools representing 11 states offered programs for training environmental technicians. Currently, there are 55 junior colleges and other institutions in 23 states offering courses in environmental technology. Twenty-one additional institutes have programs in the planning stage. Most of these programs terminate with an Associate of Arts degree in environmental technology, but many offer specialization in wastewater treatment technology. Additionally, a number of these institutions have joined with other sectors in providing non-degree programs for operators and technicians.

Two of these institutions--Charles County Community College and the Atlanta Area Technical School--offer good illustrations of this type of training activity. The Charles County Community College in La Plata, Maryland, offers a two-year Associate of Arts degree in Pollution Abatement Technology, a program centered on water pollution control.[2] It also offers a one-year Solid Waste Management Certificate program and week-long seminars on selected subjects. From 1967 to 1969, it joined with three other community colleges and the Maryland State Departments of Health and

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[1] Criteria for the establishment and maintenance of two-year post-high-school wastewater technology training programs were developed by Clemson University in 1970, under an EPA grant. Details of this activity and its impact on technician training activity are covered in subsection IV-C-2-c, Technical Training Grants and Scholarships for Undergraduate Study.

[2] This program has been funded by an EPA grant (see subsection IV-C-2-c, Technical Training Grants and Scholarships for Undergraduate Study).

Natural Resources in presenting an annual training program for municipal and industrial wastewater treatment plant operators and superintendents. This program consisted of instruction in basic science and unit operations for three hours, one night per week, for 32 weeks. A sanitary engineer from the college faculty visited each student's plant during that period to give on-site technical assistance. Three federally funded[1] (MDTA) operator training programs are presently conducted by the college:

--A 44-week on-the-job training program coupled with classroom instruction to upgrade the skills of presently employed operators.

--An Institutional Training Program for (new) entry-level operators.

--Training for military personnel scheduled for separation from the service under the Transition Training Program.

A science and technology center with classrooms and laboratories was specifically designed at Charles County Community College to support these programs. A wastewater treatment plant designed as a teaching facility was also placed into operation. Teaching aids were developed in the absence of any textbooks published on the technical level in wastewater treatment.

The Atlanta Area Technical School, the second example, was built in late 1967 as a joint endeavor between the Atlanta Public School System and the Georgia Department of Vocational Education. The school offers a two-year program in sanitary engineering technology for high school graduates, with a curriculum based essentially on that developed by the Fayetteville Technical School. Through guidance from an advisory committee of practitioners, the Atlanta Area Technical School emphasizes practical application. First-year scholarships are offered to high school seniors who participate in the school on a full-time basis, receiving credit toward high school graduation in substitution for elective courses they otherwise would be taking.

The school's in-plant division, which works closely with the industry in developing tailor-made courses to meet its particular needs, offers short courses for wastewater treatment plant operators and laboratory technicians. Under an EPA grant, it conducted a three-week pilot program in wastewater technology, designed exclusively to enhance the technical capabilities of experienced operators and to establish within these students a recognition of the worth of advanced education.

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[1] As further reported below in subsection IV-C-2-a, National MDTA-Funded Contracts.

The Atlanta Area Technical School also administers an MDTA Institutional Training Program, under a subcontract with EPA, to train entry-level operators similar to the program offered by Charles County Community College.[1]

Technical courses are also offered for technicians and laboratory workers in the water and pollution control laboratories in the greater metropolitan Atlanta area. A more comprehensive program is conducted jointly with the Georgia Water Quality Control Board, the Manpower division of the State Department of Vocational Education, and the wastewater treatment plants in the area. This program couples three weeks of classroom training with 26 weeks of on-the-job training.

b. Training Activities of Associations. Historically, associations have played an important role in the water pollution control movement. Traditionally established for special and frequently differing purposes, their individual and joint contributions and impact on training of water pollution control personnel have been significant. At the risk of excluding a number of associations whose direct or indirect contribution has been important, the training activities of four leading examples will serve to demonstrate the vital role that they serve.

The Water Pollution Control Federation (WPCF), as indicated by its title, is most pointedly involved in water pollution control activities. For over four decades it has promoted the advancement of knowledge concerning the nature, collection, treatment, and disposal of domestic and industrial wastewaters, and the design, construction, operation, and management of facilities for these purposes. It consists of 58 member associations representing approximately 20,000 individuals from the public and private sectors.

The WPCF has provided unique leadership in disseminating technical knowledge through its publications and its sponsorship and encouragement of training activities. For most of its existence, the WPCF has provided leadership and continuing support of certification and training of treatment plant operators. Its encouragement of the adoption and implementation of mandatory certification laws and regulations and its annual surveys of certification activity are highlighted in Part III of this report. Among the federation's publications is a series of Manuals of Practice (on subjects such as sewer design, construction, and maintenance and plant operation and design) and operator training courses with visual aids.

For a number of years the WPCF has conducted surveys of operator training programs of its member associations and states. The 1969 survey

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[1] See subsection IV-C-2-a, National MDTA-Funded Contracts.

(of 1968 activities), conducted by the WPCF's Personnel Advancement Committee, provided the source for the state activities data reported in subsection B-3-b of this part of the report.

In only a few cases was the federation involved in these programs independently of any member association. The WPCF does not provide training programs directly but does conduct annual conferences, seminars, and workshops. More typically, it supports the training activities of its member associations and others in indirect ways. Its operator training course outlines and visual aids have been distributed widely.

To provide pointed focus to its support of manpower and training activities, the WPCF established a manpower program called MANFORCE (an acronym formed from the phrase, MANpower FOR a Clean Environment). Generally, this program is directed at the problems of recruitment, training, certification, and retention of treatment plant operators and collection system personnel. One current MANFORCE project is the development of a central source of information on training and job opportunities. The training survey projected for 1971 will be a collaborative effort among MANFORCE, the federation's Personnel Advancement Committee, the proposed national association of boards of operator certification, and the American Waterworks Association. The survey is expected to produce not only a status report (as was done in 1969) but also a catalog of operator training programs and resources by states. Another MANFORCE project envisions an expanded role in developing and publishing instructional materials for nationwide use.

The American Waterworks Association (AWWA) is to the water supply field what the WPCF is to the field of water pollution control. Its membership exceeds 20,000, about half of whom are utility executives. AWWA has collaborated with the WPCF in many endeavors: preparation of the model law and regulations for mandatory certification of operators of water and wastewater treatment plants; co-sponsorship of conferences and workshops; co-endorsement of the proposed association of State certification boards; the 1971 WPCF survey of operator training; and joint publications of the laboratory manual, Standard Methods for the Examination of Water and Wastewater.

The AWWA has been active for many years in the implementation of water resources training programs, through its national office as well as through its many local sections. Aimed at all levels of operation up through management, AWWA courses relate closely to similar concerns in water pollution control.

Over the past few years, the AWWA has also sponsored a number of seminars and workshops conducted throughout the country. These include management seminars, treatment plant operator workshops, and a seminar on negotiating labor contracts.

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Recently, the AWWA prepared course outlines for training operators of distribution systems and three levels of treatment plant operators. The association also recently published a training manual for the first level of plant operations.

The American Public Works Association (APWA) has a membership of over 12,000 top-ranking public works officials, primarily from public agencies and utilities. The APWA Education Foundation provides a variety of education and training programs. Many are indirectly related to water pollution control due to their generalized nature (such as in-service training courses in public works administration, management seminars for top public works executives, fellowships leading to degrees of Master of Public Works, and sponsorship of public works engineer management trainee programs). Of 10 workshops on specific public works functions presented to administrative and supervisory personnel, one is oriented specifically to water pollution control: a two-day workshop on Sewage and Urban Drainage Systems, presented in cooperation with the WPCF. Eight sessions of this workshop have been or are scheduled to be presented in 1971.

The National Sanitation Foundation (NSF) is a private, nonprofit institution engaged in standard development, environmental research, testing, and education. Some of its activities are directly related to water pollution control. The foundation is most widely known for its role in developing standards and criteria for products, equipment, and services.

The NSF's programs in environmental education are noteworthy. Their primary focus has been on the environmental technician. Under a five-year grant from the Kellogg and Statler Foundations, NSF established a Program of Training and Education in Environmental Technology (POTEET). The program consists of:

--Encouraging the incorporation of environmental subjects in education for industry.

--Providing an information clearinghouse concerning curriculum.

--Teaching courses on subjects in which the NSF is expert (including in-service training of NSF staff).

The clearinghouse function is performed through the development and widespread dissemination of a current informational packet relating to curricula for the environmental technician. It is distributed to educational institutions, environmental agencies, and individuals seeking assistance in curriculum initiation. The packet consists of technician job descriptions, manpower information on the environmental technician, a categorized bibliography, a current listing of post-secondary institutions with curricula in environmental technology, and sample curricula currently in use.

The NSF also provides scholarship support for junior college teachers in environmental education. It currently provides support to more than 60 colleges.

Direct NSF training activities for industry and public agencies are in the pilot planning stage and will be funded initially from grant sources. The program is expected to include training input to satisfy industrial needs for the environmental technician, inputs to water and wastewater plant operator training courses, and expansion of the ongoing information clearinghouse for the environmental technician.

c. Training Activities of Private Industry. Virtually no data are available on the water pollution control training activities of private industry. Indeed, little detailed information is available even on the training activities of those industries most closely associated with the design, operation, and maintenance of municipal and industrial water pollution control facilities: consulting engineers, suppliers of chemicals and equipment, and industrial manufacturers involved in industrial wastewater treatment.

Industrial manufacturers employ professionals, technicians, and process operators. Professionals are hired with sufficient training to enable them to handle their job assignments. Orientation to the specific industry and its water pollution control activities generally is accomplished through informal on-the-job training (OJT). Technicians and operators similarly receive OJT, although frequently in a more structured fashion. A number of major firms have developed or sponsor formal OJT programs, sometimes with federal assistance or approval. These and other programs developed by the larger firms are normally for their own internal use. As is true with smaller municipal plants, most of the smaller industrial firms have virtually no formal training programs and rely exclusively on external resources for any formal training for their employees.

Technological advancement and the potential impact of enforcement guidelines and standards promise to create a surge in requirements for continuing education and short courses for updating, upgrading, and reorientation of industrial manpower engaged in water pollution control.

Consulting engineers and suppliers of chemicals and equipment follow basically the same pattern of OJT for their professionals and technicians. Their formal training activities for personnel in other categories are limited, but they do play an important, however informal, role in training other water pollution control personnel. In their frequent contacts with operators and administrators, representatives of these firms disseminate important information on operational problems, new processes, and new techniques. In effect, this represents an informal channel for transfer of technological innovations from research and development into practice.

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Major equipment manufacturers provide training seminars for operators and maintainers of their equipment. Generally, their representatives who conduct these seminars are highly trained and effective teachers who represent a potentially valuable instructional resource for training activities conducted by others in other settings.

3. Training Activities of Non-EPA Governmental Organizations

The public agencies have been very active in water pollution control training as enablers, as collaborators, and as recipients. Training activities at the local, State, and Federal levels vary by agency, as described in turn below.

a. Training Activities of Local Agencies. As described in subsection II-C-3 of this report, local government agencies are basically the operators and maintainers of sewage collection systems and public wastewater treatment facilities. As they vary in structure, size, organization, and budgetary constraints, so they differ in their approaches to training.

As public employers, local government agencies bear ultimate responsibility for the development of their manpower. Required training for new entrants or to update or upgrade the skills of the current workforce can be provided in a variety of ways:

--By the employer (without assistance from others).

--By the employer (with assistance from others).

--By others (without assistance from the employer).

--By others (with assistance from the employer).

Being at the point of operation of water pollution control activities, local agencies are the targets, and, hence, the beneficiaries, of training or training assistance provided or sponsored by other sectors. Little or no training, beyond OJT, is sponsored or provided independently at the local level, with the exception of the larger jurisdictions whose workforce size and concentration and whose budgets would warrant such activity.

Training needs and consequent training activities vary according to the two major manpower functions in local water pollution control: (i) staff activities of administration, planning, enforcement, and design; and (ii) operation of sewer collection systems and wastewater treatment plants.

Most of the personnel in or entering staff or chief operating positions already possess the basic technical or administrative skills required for these positions (either through work experience or as graduates of formal educational programs at universities, colleges, or technical schools). Entrants learn the unique feature of the systems and operations through informal orientation and on-the-job training. Little or no upgrade training in management or technology is sponsored or provided independently by local governments.

Operators generally receive informal orientation and OJT from their employers in the form of informal "apprenticeship" (working under the guidance of one or more experienced operators), job rotation (short supervised tours in different parts of the plant), or "chalk-talks" (briefings from senior personnel on operations, equipment, procedures, and so forth). Few jurisdictions independently sponsor or provide entry or upgrade training programs. Indeed, no patterns exist for tuition assistance, travel, or subsistence allowances or work-release policies.

A few large municipalities and sanitation districts have independently provided formal training courses for their operators. For example, the Philadelphia Water Department developed an In-Service Training Program and Operator's Guide. The operator's manual is oriented specifically for treatment plants in Philadelphia, describing plant operation, equipment, and procedures in terms of that environment. Also, the Metropolitan Sanitary District of Greater Chicago developed a four-phased, eight-month in-plant training program conducted by their own technical personnel, with guidance from a local university.

One of the most ambitious programs initiated at the local level is the well-publicized apprentice program conducted by the Orange County Sanitation District in California, which operates the third largest wastewater quality control system on the West Coast. An Apprentice I program was initiated in July 1967 for mechanically inclined entrants, newly graduated from high school. Covering a two-year period, the Apprentice I program provides general training covering all operational and maintenance activities of a wastewater treatment agency, with three-month tours spent in each of its departments. Graduates of the program are expected to become familiar with overall operations but would not have spent sufficient time in any given area to develop a journeyman skill. Consequently, a two-year Apprentice II program for these graduates was initiated in July 1969 to provide advanced and specialized training in one of five occupational areas (engineering, mechanical maintenance, electrical maintenance, laboratory, or operations). Outside schooling, equivalent to 30 college semester units, is required to supplement this OJT, at the employee's own expense and on his own time.

b. Training Activities of State Agencies. Agencies bearing primary responsibility for the water pollution control activities in their states vary considerably in their organizational orientations and their involvement in training activities. The 54 designated water pollution control agencies receiving state program grants in FY 1971 represent all 50 states, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands. Their organizational orientations are as follows:

Within health organizations	23
Within water (or natural) resources agencies	7
Separate pollution control agencies	24

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Data[1] extracted from the FY 1971 State Program Plans depict the following levels of involvement in training by the 50 State agencies:[2]

- A total of more than 104 staff man-years are assigned to training, averaging nearly 2.1 man-years per state and ranging from a high of 10.0 to a low of 0.1 man-years. When compared to total state agency staff activities, the average proportion of staff assigned to training is 4.7 percent, ranging from a high of 27 percent to a low of 0.8 percent.
- A total of $1,393,514 is being expended for training, an average of $27,870 per state. State expenditures for training range from a high of $146,000 to a low of $1,800. This investment in training represents 7.6 percent of the total expenditure budgets for those agencies, with individual states allocating from a high of 33 percent to a low of 0.6 percent of their budgets to water pollution control training activities.

Such figures may be misleading when one considers that much training that takes place in a state typically is sponsored or provided by other state agencies (such as state employment services or vocational education agencies), universities, associations, or Federal agencies. Indeed, the role of the state water pollution control agency is frequently collaborative or catalytic in nature, particularly so in recent years.

Until recently, the main sponsor of training for treatment plant operators (other than on-the-job training) has been the states through provision of short courses, ranging from one or two days up to five weeks. In its last survey[3] of operator training programs in the states, the Water Pollution Control Federation found that 44 states had active training programs in 1968, providing at least 100 courses in over 300 actual training sessions that were attended by more than 16,000 persons. These courses were and continue to be made available in collaboration with colleges, vocational schools, associations, and other state agencies.

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[1] Digest of FY 1971 State Program Plans, prepared by the Water Quality Office of the Environmental Protection Agency, August 1971.

[2] The District of Columbia, Guam, Puerto Rico, and the Virgin Islands are excluded from the following calculations because their programs are substantially funded by the Federal Government and their inclusion would distort state averages.

[3] See subsection B-2-a-(2), above.

Attempting to further expand the scope and increase the penetration of operator training, a number of state agencies have joined with other sectors in a variety of new ways. One significant breakthrough was the establishment in 1967 of the Cooperative Area Manpower Planning System (CAMPS), which is discussed in Part II of this report. CAMPS is a planning, not a funding, mechanism. However, it does provide a great potential, through persuasion and agreement, for channeling Federal assistance to states and localities for training in water pollution control. Through this mechanism, a number of states have been successful in attracting Federal financial support of state and local water pollution control training projects, primarily through program funding authorized under the Manpower Development and Training Act (MDTA), discussed more extensively in subsection C-2-a, below. Projects for institutional training, on-the-job training, and on-the-job training coupled with classroom instruction have been funded directly to the states and localities in the following approximate magnitude:

Contract Period	Cost	Number of Operators Trained
1969-1970	$1,162,000	980
1970-1971	1,110,000	1,355
1971-1972	2,712,000	2,795
	$4,984,000	5,130

Most of this activity has taken place in the Middle Atlantic States and Southeast, South Central, and Northwest regions of the country.

Current state training activities are focused primarily on operator training and mirror this collaborative approach as illustrated in the examples described below for Pennsylvania, Texas, and New England. The Pennsylvania Public Service Institute is the recognized training agency of the State of Pennsylvania for water pollution control operators. The Institute is funded equally by the State and the Federal Governments (under the Vocational Education Act of 1966, described more fully in subsection 2-b-(3). The Institute provides the instructor and training materials and presents staggered evening classes (usually three hours per night, one night a week for 10 to 15 weeks) at various locations throughout the State. It also conducts 44-week training programs supported by MDTA funding,[1] in collaboration with the Pennsylvania Department of Health.

Operator trainings in Texas is provided as a joint activity by the Texas State Department of Health, the Texas State Water Quality Board, Texas A & M University (and its Engineering Extension Service, the Texas

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[1] This program is conducted under a subcontract with the EPA. (See subsection IV-C-2-a, National MDTA-Funded Contracts.)

State Technical Institute), in cooperation with two statewide operator associations. An annual short school is held on the campus of Texas A & M, with sponsoring agencies assisting in planning, organizing, and conducting the class sessions. Regional short schools, geographically distributed among towns in which college facilities are available, are conducted by members of the State Division of Sanitary Engineering and faculty from the Engineering Extension Service. To reach operators of small plants, the Engineering Extension Service presents short courses throughout the state by traveling field instructors. Sixty to 80 of these courses are conducted annually (two and one half hours nightly, four nights a week for two weeks). For wastewater laboratory technicians, an annual 40-day course is held on the Texas A & M campus, and one- and two-year programs are available at Texas State Technical Institute, the latter culminating in an Associate of Science degree in water and wastewater technology. All of these programs are supported by fees, state appropriations (amounting to about 25 percent of the total), and Federal funds.

Finally, the New England region provided a unique and varied approach to operator training in FY 1971. The New England Interstate Water Pollution Control Commission sponsors entry-level training at the New England Regional Wastewater Institute in South Portland, Maine. Its Wastewater Treatment Plant Operators course, an ongoing program of 35 weeks of full-time classroom, shop, and OJT, is offered to all of the New England States (by either open or MDTA referrals). In addition, individual states in the region provide wastewater treatment training at the intermediate and advanced levels.

In one of these states, Connecticut, wastewater treatment training is conducted by four different state agencies. The State Department of Health and the Water Resources Commission conducted entry and upgrade training in basic principles of sewage treatment and upgrade training in secondary treatment theory and practice (40 enrollees each). The Division of Vocational Education offers entry training for waste treatment plant operators (15 enrollees) and part-time entry and upgrade training for sewage plant operators (65 enrollees). Both of these programs are MDTA-sponsored coupled OJT programs. The Department of Labor also conducts a 34-week coupled-OJT program for wastewater treatment plant operators (40 enrollees).

c. Training Activities of Non-EPA Federal Agencies. As previously indicated in subsection II-C-5, other Federal organizations engage in activities that relate directly or indirectly to water pollution control. Of the 40 other Federal organizations surveyed by EPA, seven reported that they conduct internal training programs related to water pollution control. Eight additional Federal organizations which were not included in the survey reported the availability of various funding mechanisms to support the educational activities of others involved in water pollution control. All of these organizations, including those which provide their own internal training programs, participate in courses, workshops, seminars, and correspondence courses provided by other sectors.

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The subsections below discuss the direct training and financial support for training provided by non-EPA Federal agencies in the field of water pollution control.

(1) Direct Training. The following summarizes the internal training programs reported by the other Federal organizations.

- Department of the Army

  - --A course for sanitary engineers at the Army Medical Field Service School.

  - --A course for environmental and sanitary engineers by the Army Environmental Hygiene Agency of the Office of the Army Surgeon General.

  - --A water supply specialist course for enlisted personnel at Fort Belvoir.

  - --A water supply course for NCO and supervisory candidates at Fort Belvoir.

  - --An environmental training course for headquarters personnel at Washington, D.C.

  - --A course in facilities engineering management at the Army Engineering School, Fort Belvoir.

- Department of the Navy

  - --A program for waste treatment operators and maintenance personnel at the Naval Facilities Engineering Command Technical Training Center.

  - --Correspondence courses and workshops on basic and intermediate water and sewage treatment for engineers, operators, scientists, and laboratory personnel.

- Department of the Air Force

  - --A course in waste processing for wastewater treatment plant operators at Sheppard Air Force Base.

  - --Courses for bio-environmental engineers on water hygiene and other health aspects of water and wastewater at the Aerospace Medical School.

- U.S. Geological Survey (Department of the Interior)

  --Courses and workshops on ground water, surface water, hydrologics, hydrochemistry, environmental quality, and water quality.

- Department of Agriculture

  --Courses and workshops in water systems and sewage treatment systems design and treatment plant operation by the Forest Service.

  --Educational programs (seminars, publications, media programs) in agriculturally related pollution control and rural community resource development (for example, sewage disposal and water systems) by the Cooperative Extension Service.

- Atomic Energy Commission (AEC)

  --A program to introduce college and university faculty and others to analytical techniques for monitoring, measuring, and evaluating water quality by the Division of Nuclear Education, in cooperation with the Special Division of Oak Ridge Associated Universities. (Three courses for 67 attendees were conducted in FY 1971 at a cost of $17,000 out of AEC's educational budget of $6.8 million.)

- U.S. Civil Service Commission (CSC)

  --A seminar in environmental engineering and ecology by the Dallas Regional Training Center. (Seventy-seven engineers and scientists, mainly from the Federal Government, attended in FY 1971.)

  --Management training programs for Federal, State, and local government personnel.[1]

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[1] The CSC is authorized, under the Intergovernmental Cooperation Act of 1968, to assist state and local governments in training professional, administrative, and technical personnel to increase their capability for mission accomplishment. Through a nationwide network of training centers, the CSC offers a broad range of courses in executive development, general and personnel management, communications and office skills, automatic data processing, management sciences and financial management, and labor-management relations. The CSC reports that 7,200 state and local employees attended their programs in FY 1971 (out of a total of 77,000 attendees). No specific breakdown was available to distinguish

(2) Financial Support for Training. Eight Federal organizations reported that they administer various funding mechanisms to support the educational activities of others. These activities relate directly or, in some cases, rather indirectly to water pollution control. These mechanisms are described below by the occupational category (that is, professional and technician/operator) for which the supported programs are primarily intended.

Financial Support of Training Programs for Professionals. Four organizations provide funding assistance oriented primarily to professionals--the National Science Foundation, Office of Water Resources Research, National Institute of Environmental Health Sciences, and U.S. Civil Service Commission--as discussed below.

- The National Science Foundation. Under authority of the National Science Foundation Act of 1950 (P.L. 81-507), as amended, the Foundation attempts to strengthen research and education in the sciences. Among its activities that relate potentially to the environment, the National Science Foundation supports a number of training programs with an environmental orientation. Graduate predoctoral fellowships and traineeships in the mathematical, physical, medical, biological, engineering, and social sciences are the largest single element. In FY 1971, the Foundation invested $28 million to support 3,500 predoctoral candidates. Its Office of Training estimates that about 30 percent of these awards were environmentally oriented. In its support of teacher upgrading and curriculum and materials development, the Foundation invested approximately $11 million in FY 1971, of which 20 percent is estimated to have been related to the environmental sciences. Specific breakdowns for those activities related to water quality control were not available. However, the Foundation estimates, in the aggregate, that 13 research and training projects relating to water quality control were supported during FY 1971 at a budget cost of $1.7 million.

- The Office of Water Resources Research (OWRR), Department of the Interior. The OWRR, under authority of the Water Resources Research Act of 1964 (P.L. 88-379), as amended, administers a program of water resources research and training. Through its sponsored research, it helps develop new technology and more efficient methods for resolving local, state, and nationwide water resource problems. It also helps to train water scientists and engineers through their on-the-job participation in research work.

Having no internal research facilities, OWRR supports state university water resources research and training institutes. It also

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the functional areas represented (such as water pollution control), their occupational categories, or the specific programs they attended.

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provides grants and contracts for support of urgently needed water resources research. In FY 1971, the OWRR supported 675 projects at a cost of $11.6 million, with an orientation toward the supply, rather than the quality, of water.

- The National Institute of Environmental Health Sciences (NIEHS), Department of Health, Education, and Welfare. The NIEHS conducts, fosters, and supports research and research training relating to the environmental impact on man. It is oriented tothe health aspects of environmental pollutants, with particular emphasis on biological effects. The NIEHS supported 158 projects in FY 1971 at a cost of $13.5 million. The Institute estimates that roughly 5 to 10 percent of these relate to various aspects of water improvement (such as water toxicology).

- The U.S. Civil Service Commission (CSC). The CSC develops and administers programs under the Intergovernmental Personnel Act of 1970 (P.L. 91-648). It administers a grant-in-aid program to help state and general local governments improve their personnel administration and employee training programs. Among other things, the Act provides grants for the training of personnel, for government service fellowships, and for intergovernmental assignment of personnel and cooperation in recruiting and examining. Appropriations for FY 1972 totaled $10.4 million. Guidelines for grantees were distributed in July 1971, and grant applications are expected to start in FY 1972 at an accelerated pace.

The CSC also provides technical assistance on personnel administration to state and local governments. At the request of state and local governments, the Commission assists these jurisdictions in assessing their training needs and in establishing, operating, and evaluating their own training programs.

Financial Support of Training Programs for Technicians and Operators. Four organizations provide funding assistance oriented primarily to technicians and operators: the Division of Vocational and Technical Education and the Division of Manpower Development and Training of the Office of Education (Department of Health, Education, and Welfare), Manpower Administration (Department of Labor), and Veterans Administration, as discussed below.

- Division of Vocational and Technical Education, Office of Education, Department of Health, Education, and Welfare. The Vocational Education Act (P.L. 90-576), as amended, authorizes funds to be used primarily by the states in promoting vocational education for a variety of unemployed or underemployed individuals. It is intended to assist secondary and post-secondary students, dropouts, high school graduates, and those with educational, socioeconomic, and other handicaps.

The vocational educational program is guided by a National Advisory Council, consisting of 21 Presidentially appointed members from the fields of labor and management, manpower administration, education, adult education and vocation, the general public, and those trained or knowledgeable in the special areas of the handicapped or the socioeconomically disadvantaged.

Approximately $427 million in total appropriations were available in FY 1971. The number of enrollees supported by this appropriation approximates 10 million. Most of the Federal funds require matching with state or local funds, and the states traditionally have overmatched such Federal funds four- to fivefold.

The states are allocated basic grants to provide opportunities for persons to become skilled workers, technicians, or paraprofessionals in recognized occupations. Funds generally can be allocated to support training programs; facilities construction; guidance and counseling; ancillary activities; research, experimental, and demonstration programs; and curriculum development. Funds are generally administered through the State Director of Vocational Education in each state, with the advice of required State Advisory Councils (mirroring the national membership representation from educational, vocational, and technical fields). Federal funds for basic grants in FY 1971 approximated $322 million. Mandatory set-asides were established for post-secondary programs and programs for the disadvantaged and the handicapped.

Additionally, special vocational education programs may be funded to support additional activities such as:

--Exemplary programs and projects which broaden occupational aspirations and create job opportunities for young people through activities such as career opportunity familiarization, work experience, and job placement ($16 million available in FY 1971).

--Cooperative vocational education programs ($18.5 million available in FY 1971) and work study programs ($5.5 million available in FY 1971).

--Curriculum development activities[1] ($4 million available in FY 1971).

The Division of Vocational and Technical Education reported that approximately 10 states provided vocational education programs related to water quality treatment or improvement (such as training in water and wastewater technology) during FY 1971 for approximately 2,500 enrollees at a budgeted cost of approximately $750,000.

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[1] The joint interdepartmental publication, Water and Wastewater Technology, A Suggested 2-Year Post-High-School Curriculum (1968), was developed from materials prepared under a grant to the Fayetteville Technical Institute in 1965. [Discussed in subsection 2-a-(1), above.]

- Division of Manpower Development and Training, Office of Education, Department of Health, Education, and Welfare. The Secretary of Health, Education, and Welfare is given responsibility for providing all institutional training required for referrals under the Manpower Development and Training Act (MDTA) of 1962, as amended. The Act generally authorizes the expenditure of Federal funds to reduce the level of unemployment, offset skill shortages, and increase the productivity and earning power of the nation's work force. These objectives are accomplished by offering diverse skill training opportunities to the unemployed and underemployed in occupational areas with immediate manpower needs. The institutional training component of the MDTA programs includes basic education and employment orientation and supportive services. Distinctively, institutional training is oriented to the classroom, rather than the work site.

Funds for institutional training are either administered through interagency agreement with EPA or channeled directly through appropriate state education agencies to public or private educational agencies or institutions, multi-occupational projects, and manpower skill centers. Federal funds granted directly through the states are matched by state funds on a 90/10 sharing basis.

Approximately $131 million was available in FY 1971 to provide institutional training for approximately 149,000 enrollees under the MDTA program. No breakdowns were available to distinguish that portion of the institutional training appropriation related directly to water pollution control through direct grants. Those MDTA institutional training programs provided under agreement with EPA are discussed in subsection C-2-a(2) of this part of the report.

- The Manpower Administration, Department of Labor (DOL). Two programs administered by the Secretary of Labor pursuant to the Manpower Development and Training Act of 1962, as amended, have direct relevance to and have been significant sources of funding for training in water pollution control: the Coupled On-The-Job Training (OJT) Program and the Public Service Careers (PSC) Program. MDTA funds are also expended in support of the Transition Program of the Department of Defense. Part of each of these programs is administered under interagency agreement with EPA; these arrangements are discussed in subsection C-2-a, below. The MDTA programs are discussed in general terms below.

(i) The Coupled OJT Program

The Secretary of Labor is authorized to expend Federal funds for the provision of programs for on-the-job training. Through contracts with the Department of Labor, public and private employers provide supervised work at the

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job site for entry employees hired from the ranks of the disadvantaged or for those employees requiring skills upgrading. Upgrade training is oriented to low-skilled workers trapped in low-paying jobs (the "working poor") and to occupational positions with skills shortages. Projects which include related supplementary classroom instruction are referred to as coupled institutional and on-the-job training or, more commonly, coupled OJT. (When so combined, joint DOL and HEW funding is provided under interagency agreement, although the separate funding channels are maintained for administrative purposes.)

No statistics regarding funding and enrollment for OJT or coupled OJT programs or for those specifically related to water pollution were available. EPA involvement in the Coupled OJT program is discussed in subsection C-2-a-(1) of this part of the report.

(ii) The Public Service Careers Program

The PSC Program was launched in FY 1970 under the authority of the MDTA and the Economic Opportunity Act. The program is designed to provide permanent jobs in government service agencies for disadvantaged workers and also to assist in upgrading employees in dead-end, low-paid positions. Based on a "hire first, train later" concept, the PSC Program helps defray part of the costs of OJT and intensive supportive services for disadvantaged workers hired by public agencies and also helps finance upgrading activities. It is the counterpart program to JOBS (Job Opportunities in the Business Sector).

The program has four major plans, two of which have potential relevance to manpower training in water pollution control:

--Plan A provides for the award of contracts directly to State, county, and local government agencies and independent special districts for entry and upgrading of disadvantaged workers. Although the workers' salaries and fringe benefits are paid from the employing agency's regularly budgeted funds, PSC funds are intended to defray the extraordinary costs of training. The upgrading phase, restricted to agencies that have an entry project, is focused on the underutilized, low-income employee.

--Plan B provides for entry employment and upgrading in Federal grant-in-aid programs. The Department of Labor negotiates agreements with other Federal agencies to build arrangements into their grant-in-aid programs with State, county, and local government agencies and independent special districts. The Federal grant agency negotiates and awards contracts or provides grants to these sponsors. The basic concepts of Plan B are identical to those of Plan A.

No figures were available on the funds provided under Plan A which were related to water pollution control. Activity under Plan B is discussed in subsection C-2-a-(3) of this part of the report. (Although no data were available at the time of final preparation of this report, the Emergency Employment Act of 1971 (P.L. 92-54)[1] may provide additional funding assistance opportunities for employment and training in water pollution control.)

(iii) The Transition Program of the Department of Defense (DOD)

The DOD has estimated that about 20 percent of servicemen about to separate from the military lack the educational or civilian job-related skills required for transition to civilian employment. The Transition Program was established to provide occupational training to provide marketable skills, educational reinforcement to upgrade to secondary or high school equivalency levels, counseling to determine career desires and educational and training choices, and job placement assistance to locate employment opportunities or to secure jobs during the six-month period immediately prior to separation. Both classroom and on-the-job training are provided by cooperating public and private organizations. OJT programs are arranged with public agencies or private employers, while institutional training programs are scheduled on or near military bases. During FY 1970, approximately $4 million in MDTA funds were used to train about 12,000 servicemen in a variety of occupational areas, including water pollution control.

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[1] The Emergency Employment Act of 1971 authorizes the Secretary of Labor to provide public employment for unemployed workers by entering into arrangements with:

--units of Federal, State, and general local government;
--public agencies and institutions which are subdivisions of state or general local government, and institutions of the Federal Government; or
--Indian tribes on Federal or State reservations.

The purpose of the Act is to provide unemployed and underemployed persons with transitional employment in jobs providing needed public services during times of high unemployment and, wherever feasible, to provide related training and manpower services to enable such persons to move into employment or training not supported under this Act.

The Secretary of Labor is authorized until 30 June 1973 to obligate funds when the unemployment rate equals or exceeds 4.5 percent for three consecutive months. The mechanism is automatic and provisions in the law were activated when signed by the President on 12 July 1971, since the unemployment rate had been above 4.5 percent for the requisite time period. This Act represents a possible source of funds for transitional employment for the unemployed to work in public agencies concerned with water quality. It provides for the payment of 90 percent of wages and salaries in public employment, up to a total Federal share of $12,000 per year per employee. The Act authorized the appropriation of $750 million in FY 1972 and $1 billion in FY 1973.

- The Veterans Administration (VA). Under authority of the Veterans Readjustment Benefits Act of 1966, as amended (more commonly considered the "GI Bill"), the VA provides rehabilitation and education benefits for veterans of post-Korean conflict service. Among those benefits are the following which have particular relevance to preparation and training for water pollution control activities:

--First priority for veterans for referral to and selection for federally sponsored manpower training programs. (In FY 1970, over 20 percent of new enrollees in MDTA institutional and OJT programs were veterans.)

--Remedial educational benefits for veterans without high school diplomas or equivalency, without reducing their entitlements for college or vocational allowances.

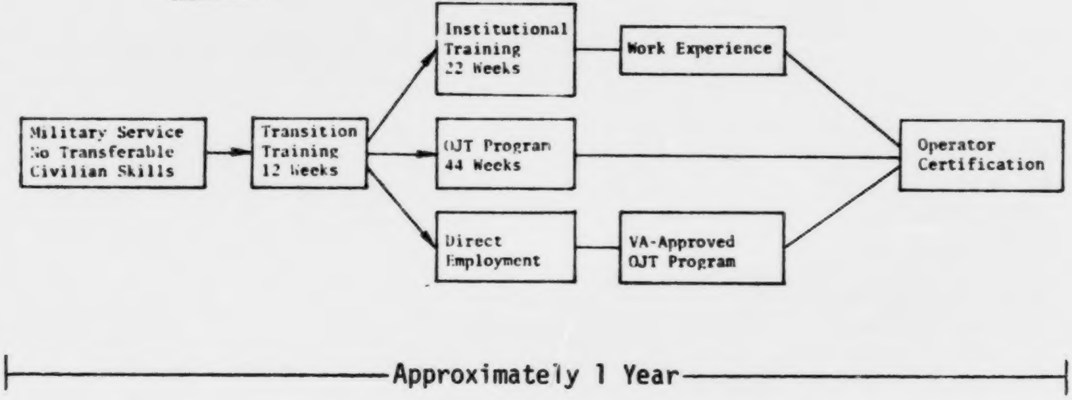
--Monthly allowances ($175 minimum) for attendance at universities or two-year colleges or in approved OJT programs. (Nearly 10 percent of Vietnam era veterans who have received educational training benefits have been enrolled in apprenticeship or other OJT programs.)

--Simultaneous payments of training allowances under both the GI Bill and the MDTA.

The President's Committee on the Vietnam Veteran recommended that the VA use provisions of the GI Bill to develop additional OJT courses that serve a public need. An approved OJT program requires an employment commitment and may last from six to 24 months. Water pollution control was one major area specified in the recommendation.

To fulfill this and other recommendations of the Committee, the Jobs for Veterans campaign was launched in late 1970. Additionally, the President's Veterans Program, announced in mid-1971, provides further emphasis on the coordination and utilization of Federal resources and programs for the returning veteran. Participation of veterans in federally assisted programs is expected to increase substantially. Those federally sponsored programs discussed above which provide training opportunities for veterans (and which can be targeted to water pollution control activities) are illustrated below:

ALTERNATE CAREER PROGRESSION FOR TRANSITION GRADUATES


Military Service
No Transferable
Civilian Skills
Transition
Training
12 Weeks
Institutional
Training
22 Weeks
Work Experience
OJT Program
44 Weeks
Direct
Employment
VA-Approved
OJT Program
Operator
Certification
Approximately 1 Year

4. Assessment of the Training Activities of Non-EPA Organizations

Against the frame of reference established at the beginning of this section, the roles played by the non-EPA organizations and the orientation and the contribution of their training activities in meeting the current and evolving training needs of water pollution control professionals, technicians, and operators will be assessed in terms of:

- Their capacity to train manpower for water pollution control (facilities and instructors).
- Their development of information with which to provide that training (curricula and materials).
- Their financial support provided to others to enable the training to be initiated and conducted.

Broad measures of training effectiveness, in terms of the comprehensiveness, coordination, responsiveness, and overall economic value of these activities, underlie both the assessment of roles and the assessment of contributions in responding to occupational needs.

a. Assessment of Roles. The primary role of four-year colleges and universities has been the direct provision of entry training for professionals. Formal degree programs offer the potential capacity to fulfill that role, but in spite of the financial support received from other Federal agencies, these programs have not been oriented pointedly to water pollution control. Although the four-year colleges and universities have great potential for extending their capacity to train professionals already working in this field, they have not been sufficiently active in doing so. Capabilities for transferring technology developed in research have not been fully established, and financial support is required.

Two-year colleges and technical schools, despite their relatively recent attention to water pollution control, represent the primary resource for entrants at the technician or upper-operating levels. The capacity of these institutions needs to be increased substantially. These institutions also have the capacity for providing remedial or transitional education for the unemployed or for those in the work force whose educational deficiencies prevent their upward mobility. This capacity has been tapped to a limited extent under programs funded under the Manpower Development and Training Act. However, two-year college and technical school entry programs require expansion and distinctive orientation to water pollution control, in general, and wastewater treatment technology and operations, in particular. Curricula must be standardized, and basic training materials need to be developed and refined or reoriented.

Two-year colleges and technical schools have been virtually inactive in providing upgrade training for technicians and operators at the higher levels. Upgrade training programs need to be expanded considerably, and financial support from non-EPA Federal agencies, which has not been pointed specifically to these needs, should be applied to improve the capabilities of these institutions.

Associations have been extremely active--and successful--in inviting enlightened attention to the deficiencies in manpower training, especially for wastewater treatment plant operators. They have encouraged the improvement of operations through their support of mandatory operator certification, their promotion of increased capacities for training of operators and technicians, and their sponsorship, through local units, of short courses. Their catalytic and enabling roles are limited, to large degree, by their size and financial constraints. Associations require support for their special areas of interest and expertise. Collaborative efforts with government agencies should be increased.

Employers in the private sector (industrial manufacturers, consulting engineers, and suppliers of chemicals and equipment) have generally attended to the training needs of their own employees. Only the larger firms have developed formal programs; only suppliers and, to a limited degree, consulting engineers appear to offer formal training programs for use of others. Programs need to be developed to respond to the anticipated expansion of industrial wastewater treatment activities. Governmental and nongovernmental roles in this endeavor need solidification.

Local governments and agencies have been constrained severely in their training activities by their size and their budgetary limitations, but they have been the beneficiaries of considerable support from the state and Federal sectors. Only the larger jurisdictions have conducted independent training activities beyond the scope of informal orientation and on-the-job training. A number have been the direct or indirect recipients of Federal funds, primarily under one of the MDTA-sponsored programs. Local government agencies should play a greater role in shaping the nature of their training to their own particular environment. Encouragement and financial support are needed to make better use of training and manpower resources available to fill their needs.

State water pollution control agencies traditionally have sponsored short courses for operators, frequently in collaboration with others. These agencies have suffered with inadequate staffing and funding to perform fully their enabling roles. They also have operated fragmentally in pursuit of common goals with their sister agencies (employment, education, health) whose categorically distinctive orientations frequently inhibit, rather than encourage, collaborative action. When collaboration has been evident, striking results have been achieved. Collaboration has been most noteworthy in the states' involvements with short courses. Indeed, the state's most active role has been collaborative sponsorship of short-course

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upgrade training for operators and participation in MDTA-funded entry and upgrade programs, of longer duration, for lower level operators. Independent support of the direct training activities of others has been limited.

State water pollution control agencies need strengthening by increased staffing and financial support to build their capacity for planning, organizing, administering, and conducting training programs. Closer cooperation and coordination among agencies within a state are required to maximize the potential of the resources they collectively can marshall for water pollution control training. Additionally, their independent efforts require general coordination and guidance to ensure reasonable consistency among the states and to capitalize on opportunities for widespread replication of individual efforts on a regional or national scale.

The roles of non-EPA Federal agencies have been varied. A limited role has been played in the provision of direct training for those engaged in water pollution control. Limited internal training activity has been reported by those Federal agencies which operate their own treatment facilities.[1] These programs apparently have been planned and developed independently. The management training provided by the Civil Service Commission is designed for general purposes and is presented to heterogeneous groups at the Federal, state, and local levels.

Substantial Federal financial support is provided to educational institutions. Funds provided by the National Science Foundation support the basic sciences and are generalized in orientation. Similarly, vocational educational support by the Office of Education is generalized (about 0.2 percent of the program funds were reported to have been directed specifically to water and waste treatment technology). Support provided by the Office of Water Resources Research and the National Institute of Environmental Health Sciences is related only tangentially to water pollution control (the former primarily to water supply and the latter to the environment's impact on man).

The MDTA-funded programs administered by the Manpower Administration and the Office of Education have been used actively and productively in some of the states. Expanded use is required to realize their full potential. The Institutional Training Program and the Transition Program offer a source of entrants prepared to assume lower level operator positions. Their maximum effectiveness is achieved when oriented directly to water pollution control. The Coupled-OJT and Public Service Careers programs offer potential for both entry and upgrade training for lower level operator positions. Plan A of the PSC program offers funding of water pollution control training projects directly to state and local governments;

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[1] Executive Order 11507 requires compliance of Federal installations to water quality standards for Federal facilities by the middle of FY 1973. It also requires that all Federal operators meet or exceed the state operator qualification standards for their locale.

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yet little activity has been reported. Finally, pointed use of veterans' benefits under the GI Bill has potential for increasing the reservoir of trained manpower for entry into water pollution control activities.

Like the states, potentials for assistance from non-EPA Federal agencies are great, efforts have been fragmentary, and pointed orientation and coordination of resources toward water pollution control have been inadequate.

As evidenced in the foregoing assessments, the roles played by others have been varied and closely interrelated. Certain limitations and requirements for supplementation have been evident. These are synopsized in Exhibit IV-1.

EXHIBIT IV-1
SYNOPSIS OF PRIMARY ROLES AND LIMITATION OF OTHERS IN THEIR TRAINING ACTIVITIES IN WATER POLLUTION CONTROL (WPC)

SECTOR	PRIMARY ROLE	LIMITATIONS
Four-year Colleges and Universities	Direct entry training for professionals.	--Financial support for WPC-oriented program development and student incentives is limited. --Technology developed in research activities not transferred to existing professionals. --Upgrade activities insufficient.
Two-year Colleges and Technical Schools	Direct entry training for technicians and upper-level operators.	--Financial support for programs not distinctively oriented to WPC, in general, or wastewater treatment technology and operations, in particular. --Curricula not standardized. --Training materials inadequate. --Upgrade activities insufficient.
Associations	Catalyst in support of the training activities of others, through information dissemination and collaborative sponsorship of upgrade training.	--Staff and financial resources insufficient.
Private Industry	On-the-job training for own internal purposes.	--Ability to respond to anticipated expansion of wastewater treatment activities questionable. --Only the larger firms develop formal programs.
Local Agencies	On-the-job training for own internal purposes. Target and beneficiary of training activities of others.	--Size, concentration and budgets vary. --Staffing and financial resources insufficient.
State Agencies	Collaborative sponsors of short courses for operators.	--Staffing and financial resources insufficient. --Interagency collaboration limited. --Coordinative focal point absent. --Capacity to train inadequate.
Non-EPA Federal Agencies	Financial assistance in support of educational institutions for entry programs. Funding (MDTA) of entry and upgrade training for operators at the lower levels.	--Direct training very limited. --Support of educational institutions very generalized or not oriented to WPC. --MDTA funding limited in scope. --Interagency collaboration limited. --Coordinative focal point absent.

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b. Assessment by Occupational Needs. The focus of manpower training ultimately must be on the man--the target and immediate beneficiary of the training. An assessment of training activities is incomplete without examining the orientation and contributions of those activities in meeting the needs of the major occupational categories of manpower for water pollution control:

- Professionals
- Operators and Technicians

For each of these categories, activities will be assessed in terms of their orientation (entry or upgrade training) and their contribution (needs satisfied and needs unmet).

(1) Training for Professionals. As the complexity of water pollution control increases, so do the number of professional disciplines involved and the extent of training required to cope with its problems. The distinctive entry and upgrade orientations necessary in professional training provide a valuable tool for assessing the adequacy of current activities in the training of professionals for water pollution control.

Entry Training for Professionals. Water pollution control programs require a wide range of professional talents. Technical problems are increasingly complex; management demands offer substantial professional challenge. Clearly, higher levels of formal education, in depth within the technology and in breadth across disciplines, are required. A pointed orientation to water pollution control is necessary, but attention must be given to the management of technology as well as to the technology itself.

Direct entry training for professionals has been provided largely by four-year colleges and universities, who have provided the capacity and have developed the information necessary to prepare professional entrants through degree programs, primarily at the graduate level. Programs have been scientifically oriented, with limited emphasis on practical operations and managerial considerations. As suggested by Professor John H. Austin of Clemson University, "Design and operation of plants are two sides of the same coin and graduates of university programs must have an understanding of the necessity for proper operation and ways this might be effected; this is not believed to be the case at present."[1]

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[1] Conference Proceedings, Educational Systems for Operators of Water Pollution Control Facilities, Atlanta, Georgia, 3-5 November 1969, sponsored by Federal Water Pollution Control Administration in cooperation with Clemson University, Clemson, South Carolina, pp. 137-140.

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Financial assistance for university efforts has come primarily from the Federal sector. The impact of funds provided by other Federal agencies has been positive in increasing the total professional labor pool. Its direct impact on water pollution control has been limited, since most of the support has either been generalized or oriented to subjects only tangentially related.

Update and Upgrade Training for Professionals. Short courses offer the best potential for updating the skills of professionals in the field and for developing transitional skills in those recruited from allied fields. The rapid rate of technological change mandates the need for transfer of technology to practitioners. The complexity of the technology and its management dictates the need for a broad range of subjects, from basic scientific skills to the sophistications of advanced technology of the management sciences.

Little update or upgrade training has been directly provided for professionals by the universities, the private sector, or by state or local government agencies. Programs of other Federal agencies are limited in number, generalized in scope, and relatively inaccessible to water pollution control professionals in the field.

(2) Training for Operators and Technicians. Operators comprise a wide range of personnel, from the lower level operator who requires a rudimentary knowledge of wastewater treatment processes and operational techniques, to the chief treatment plant operator who manages a large and complex advanced wastewater treatment facility and who supervises a number of operational personnel. Each level of skill within this range requires a correspondingly specialized level of training.

The educational requirements of a technician are reasonably compatible with those of operators at higher levels of skill or organization. Assessments of training activities and, indeed, the formation of training programs should recognize this commonality of needs as quite distinctive from those of the lower level operator. Therefore, the needs of lower level operators and those of technicians and upper level operators are discussed separately below as parameters for assessing current training activities.

Lower Level Operators

- Entry Training for Lower Level Operators. Jobs in the lower portion of the operator structure generally require lower educational qualifications and involve less sophisticated types of job responsibilities than do jobs in the upper levels. The high school graduate or those whose educational skills can be raised to that level are the prime candidates for entry to these jobs. Vocational orientation for the high school graduate can be and generally is provided by on-the-job training programs, either informally or formally structured. Repair of academic deficiencies and concomitant requirements for vocational preparation generally necessitate a more structured and lengthy program.

This type of training requirement suggests a set of conditions compatible with various national social programs designed to assist the disadvantaged, particularly those programs funded under the Manpower Development and Training Act. Pretechnical programs to repair academic deficiencies, such as institutional training, permit the potential entrant to reach a degree of productivity, once in a job, much earlier than if he were to enter the job without such training. Programs which combine institutional training with OJT (such as Coupled OJT, Public Service Careers, and the Transition Program) offer even more potential for acceleration. The most effective form of job-related training is at the field level, where entrants are able to work with and ask questions of practitioners.

MDTA-funded programs have been arranged directly with some agencies to help prepare entrants for lower level operator positions. The scope of states and localities covered and the level of funding have been inadequate. For the most part, programs have been centralized at the larger facilities or in urban locations where large numbers of the disadvantaged are concentrated. Qualified instructors have been difficult to recruit and train; of the alternatives of either teaching the teacher about operations or teaching the operator to teach, the latter has been considered preferable but not enough instructional programs have been available. Curricula and materials for these programs require focus and standardization. The absence of centralized coordination at the national level raises potential and inevitable questions of quality control and economies of resources. Dozens of separate, uncoordinated programs dilute the potential for economic attainment of national objectives.

Unmet needs include:

- Expansion of MDTA-funded programs in coverage (to more states and localities), location (accessible to smaller facilities), and funding levels (beyond that currently provided directly to states and localities).
- Programs to equip operators with requisite teaching skills to instruct in entry-level programs.
- Curricula and training materials tailored to the comprehensive needs of entry-level operators at the lower echelons.
- Alternative entry-level programs to reach that portion of the available entrant pool who do not meet the requirements as "disadvantaged" for MDTA program eligibility.

- Update and Upgrade Training for Lower Level Operators. Updating the skills of those already employed at lower levels and upgrading those employees to higher level positions has traditionally been accomplished informally, on the job, through contact with those who possess the advanced knowledge or skills. Few formal programs had been developed prior to 1968, when operator training began to receive intensive emphasis by all sectors.

State-supported programs, presented independently or in collaboration with associations, have been of relatively short duration. Those programs that extend over a period of weeks have been limited in quantity. Comprehensive approaches, such as that illustrated in Texas, have been the exception rather than the rule. Some of the MDTA programs funded directly with states and localities (Coupled OJT or Public Service Careers, Plan A) have included components to upgrade existing employees in lower level positions who are disadvantaged ("the working poor") or whose advancement would help to alleviate occupations with skills shortages. The same limitations apply to this component as were described previously for the entry component (limitations in coverage, location, funding, instructors, curricula, materials, and coordination). In particular, upgrade programs for lower level operators must be responsive to the needs of local personnel and offered in locations that will provide, not deny, opportunities for convenient attendance. Problems in reaching smaller communities are compounded by the costs of travel and the necessity to provide relief operators.

Unmet needs are the same as those outlined for entry programs for lower level operators.

Technicians and Upper Level Operators

- Entry Training for Technicians and Upper Level Operators. Technicians, by their very title, may require very specialized technical training--ranging from computer technology to the operation of sophisticated analytical equipment. Their close working relationships with professionals and operators suggest expanded educational preparation to include a basic appreciation of those functions as well.

Most technicians currently engaged in water pollution control activities are experienced plant personnel promoted through the ranks. Those in specialized positions may require degrees at the associate level, although the orientation of programs of two-year colleges to water pollution control technology has been too recent to produce a substantial number of graduates already in the field. A number of current technicians hold bachelor's degrees, although many consider them to be underemployed. Technicians require post-secondary training, either in one-year or two-year programs at community colleges or technical schools. Associate degree programs particularly oriented to water pollution control technology are required for specialized laboratory work.

Personnel for the higher echelons of the operator structure have correspondingly higher entry requirements than those at the lower levels. Their jobs characteristically include supervisory responsibilities, necessitating a much more comprehensive understanding of the plant's various processes and their interrelationships. To perform effectively, the upper level operator must obtain a thorough understanding of the complete technology of the entire plant system and the scientific principles that govern the effectiveness of wastewater treatment. Higher level operators require a balanced education to comprehend the principles (the basic sciences), apply them practically (the treatment process), and supervise their activities (the management of technology). The educational preparation required for these positions is no less demanding than that required for the entrant technician. (Indeed, many jurisdictions require a bachelor degree or higher for their superintendents or chief operators; many argue that an associate degree, properly tailored, is sufficient.) Certainly, the movement toward larger and more complex plants suggests the desirability of high educational levels. This educational background should be provided at least at the two-year college or technical school level.

Substantial amounts of Federal, state, and local funds are potentially available for the education of skilled operators and technicians, primarily through the two-year colleges and technical schools. However, financial support from these levels and stimulation from other Federal agencies, for the most part, has been generalized without pointed focus to water pollution control. Graduates of these programs should be prepared for employment in upper level operator positions or as technicians (in research and development, industrial sales and service, design and construction, regulatory agencies, and larger treatment facilities).

The development and implementation of programs in wastewater treatment technology in two-year institutions have not kept pace with the need for adequately prepared entrants. Programs generally have been inadequate, both in quantity and quality. Curricula have been varied and require standardization. Training materials and an instructional cadre have been slow in development.

Unmet needs include:

- Development of criteria for the establishment, maintenance, and improvement of programs at two-year colleges and technical schools.
- Refined curricula and tailored training materials.
- Expansion of the available instructional cadre.

- Upgrade Training for Technicians and Upper Level Operators. Increasing the skills of technicians in the work force offers a substantial potential to increase the productivity of the professionals with whom they work and some of whose responsibilities they can assume. A wide range of updated and expanded skills is required to realize this potential. Many operators at the higher levels have been promoted through the ranks. Updated and upgraded skills are required, particularly in advanced treatment and the management sciences. Generally, state agencies in collaboration with others have been most active in sponsoring short courses. The type and number have varied substantially. The states have been restricted in these activities by inadequate resources and capacity.

MDTA-funded programs are not designed primarily for this level of employee. Direct training programs of other Federal agencies have not focused on wastewater treatment technology or its management.

Universities have been involved sporadically. Technology transfer opportunities have not been fully exploited.

Two-year colleges and technical schools have not had limited involvement; their major orientation, however recent, has been in long-term resident programs. Once the institutional capacity is in place, they represent a logical source for development and expansion of upgrade training programs.

Unmet needs include:

- A comprehensive program of direct training oriented specifically to the updating and upgrading of skills required by technicians and operators at the higher levels (particularly those skills related to expanding technology).
- A formal mechanism for technology transfer to these practitioners.
- Tailored curricula and training materials and improved instructional capabilities.
- Training programs in management and supervision, oriented to the specific environment of the operator and technician.
- Increased capacity and resources in the states to initiate, develop, administer, and present innovative and responsive training (for this and other purposes).

The contributions of others in satisfying the training needs of the major occupational categories of manpower in water pollution control have been substantial, but a number of needs remain. Unmet needs are synopsized in Exhibit IV-2.

EXHIBIT IV-2
SYNOPSIS OF UNMET NEEDS IN WATER POLLUTION CONTROL (WPC) TRAINING

OCCUPATIONAL CATEGORY	TYPE OF TRAINING	CAPACITY	INFORMATION	FUNDS
Professionals	Entry	In place, requires expansion.	For training of professionals other than sanitary engineers, inclusion of WPC information. For training of all professionals, practical operational and managerial matters.	Financial support to develop and maintain capacity and information for programs with these characteristics.
	Update/Upgrade	A comprehensive program of direct training oriented specifically to the updating and upgrading of skills required by the professional in WPC.	A formal mechanism for technology transfer to the practitioner.	
Lower Level Operators	Entry and Update/Upgrade	Expansion of MDTA-funded programs in coverage, location, and funding levels. Improved coordination of efforts. Programs to equip experienced operators with requisite teaching skills to instruct in these programs. Alternative programs to reach that portion of the available pool that do not qualify as "disadvantaged" according to the eligibility requirements of MDTA programs.	Curricula and training materials tailored to the needs of operators at the lower level.	Financial support to develop and maintain capacity and information for programs with these characteristics.
Technicians/ Higher Level Operators	Entry	Development of criteria for establishment, maintenance, and improvement of these programs.		
	Entry and Update/Upgrade	Expansion of the available instructional cadre.	Tailored curricula and training materials.	Increased capacity and resources in the states to plan, initiate, develop, administer, and present innovative and responsive training programs.
	Update/Upgrade	Training programs in management and supervision, oriented to the specific environment of the operator and technician.	A formal mechanism for technology transfer to the practitioner.	

5. Conclusions Regarding the Training Activities of Non-EPA Organizations

The needs for training water pollution control manpower are generally recognized and the multiplicity of needs has suggested a multiplicity of approaches from all sectors concerned. As a result, the basic institutional framework for developing and delivering the training is generally established.

Efforts of others have been constrained in numerous ways, however. Capacities have been established but are insufficient to meet the expected demand for manpower oriented specifically in water pollution control. The training information which has been developed is not sufficiently tailored to meet the comprehensive and diversified needs of the potential or existing work force. Financial support potentially available to develop both these capacities and the requisite information has not been provided outside EPA in sufficient amounts and has not been effectively channeled to meet the demonstrated needs.

Programs that have been implemented have been parochial in their orientation: professional training has been largely restricted to graduate level entry programs; lower level operator training has been concentrated in centralized locations, oriented primarily to the environments of the larger facilities; and training for technicians and higher level operators has been sporadic and narrowly focused. A comprehensive strategy to focus programs on particularized and comprehensive needs has not been developed by the independent or collaborative efforts of others.

These efforts have been fragmented and have suffered from a conspicuous lack of coordination. As a result, programs have proliferated, overlapping and competing for scarce resources. These scarce resources have not been allocated either efficiently or effectively, thereby reducing the return on their investment. Mechanisms for achieving economies, through interagency coordination and consequent channeling of resources to priority needs in water pollution control training, have not been fully developed.

Responses by others to the evolving training needs of professionals, technicians and operators have been incomplete. The Environmental Protection Agency, through its Office of Water Programs and its predecessor organization, the Federal Water Quality Administration, has attempted to overcome these limitations, supplement these roles, and satisfy these unmet needs, as reported in Section C, below.

C. EPA Water Pollution Control Training Activities

The Environmental Protection Agency has undertaken the development of a multifaceted training program to supplement the roles played by others, to help overcome the limitations of their activities, and to attempt to satisfy the unmet training needs of the professionals, technicians, and operators in or entering the field of water pollution control.

The skills and abilities of these personnel represent an essential resource in the nation's effort to restore and protect the environment. As established in Part II of this report, the qualified manpower pool in water pollution control is insufficient to meet the expanding demand in both the private and public sectors. Additionally, many of those employed in the field are undertrained, have skills too narrowly focused, or possess educational backgrounds and experience that are dated in terms of an expanding technology.

Under its charter, EPA has attempted to help respond to these deficiencies through the conduct and support of training activities designed to expand the number and improve the abilities of personnel engaged in water pollution control. In doing so, EPA has shaped its training activities according to a fundamental three-step training strategy:

- Determination of the various training needs and their order of priority.
- Development of carefully tailored training approaches making maximum use of existing resources.
- Implementation of approaches in a cost-effective manner.

EPA activities in determining training needs have been reported in Part II above. Of most significance is EPA's intention to help develop this capacity in other sectors, particularly in the States.

The EPA strategy for developing effective and comprehensive approaches to training again relates to the essential ingredients of any manpower training program: requisite capacity, information, and financial support. Once a need has been identified, capacities must be identified or developed and supported to respond to that need. It is EPA's policy to work within the existing institutional framework and to develop and encourage the use of new mechanisms for the delivery of training at the point closest to the source of the need. EPA's strategy is to help build this capacity and to supplement, rather than supplant, the activities of others only when they are unable to respond in a timely fashion. EPA is attempting to ensure that a sufficiently wide range of facilities and accessible, qualified instructors are available to respond to the full variety of training needs.

Once capacities are identified or developed, the information with which to train must be available to respond to the identified need. Given EPA's knowledge of the latest technology in water pollution control and its focus on matters of national concern, the Agency is in a position to encourage the development of information most responsive to the needs of water pollution control manpower. Accordingly, EPA's strategy is to encourage and support or to help build the capacity of others to develop curricula and training materials tailored to the variety of needs that exist or are evolving. As noted previously, a full complement of information (formal courses of varying duration, correspondence courses, training aids, programmed instruction) may frequently be needed to respond comprehensively and at differing stages and levels of need.

To help build these capacities and develop the requisite information, EPA provides technical and financial support to others and helps channel the support and resources that can be provided by others, all specifically pointed to training in water pollution control. To accomplish this objective, EPA must coordinate closely with others, particularly with other Federal agencies whose support, resources, and programs share compatible objectives. EPA must also help coordinate the efforts of others and encourage parallel coordination among others to promote optimum allocation of resources.

In implementing this strategy and in supplementing the roles of others, EPA has focused its programs to:

- Support universities and individual students, mainly at graduate levels, in programs leading to professional careers in water pollution control.

- Provide a direct mechanism for continuing training of these and other personnel, conveying through this mechanism the results of technological advancements in the field.

- Expand the coverage of programs of other Federal agencies to channel their resources more effectively to the manpower training needs in water pollution control.

- Build the capacities of the states and two-year educational institutions to help provide an adequately trained corps of treatment plant operators and water pollution control technicians.

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In shaping its training programs, EPA has attempted to satisfy the unmet needs of the professionals and the operators and technicians who constitute the existing or potential manpower required to control water pollution. The EPA activities in water pollution control training are described and assessed in this section of the report.

1. EPA Training for Professionals

EPA has long been a vital source of training support for professionals preparing for or engaging in the water pollution control effort. As authorized by the Federal Water Pollution Control Act of 1956 and its subsequent amendments, EPA has attempted over the years to respond to the entry, update, and upgrade training needs of these professionals through the following programs:

- Professional Training Grants:[1] Awards to educational institutions for the establishment, expansion, and improvement of graduate level programs in water pollution control, including traineeships for participating students (principally masters degree candidates).
- Research Fellowships:[2] Awards to individuals, primarily predoctoral students, for selected specialized research training in water pollution control.
- Technical Training:[3] Training in technical matters relating to the causes, prevention, and control of water pollution, including:
  - --Direct training in specialized and advanced subjects, not generally available elsewhere.
  - --Activities in support of technical training.

Additionally, EPA has recently established a program to facilitate the transfer of new technology from its developers to those who bear responsibility for operational applications.

Actions taken under these programs will be summarized and assessed in this subsection of the report; conclusions then will be drawn concerning their responsiveness in satisfying the needs for professional training left ummet by others.

a. The Professional Training Grants Program

(1) Scope and Activities of the Professional Training Grants Program. EPA is authorized[4] to make grants for training projects

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[1] Authorized and administered under subsections 5(a)(2) and 5(g)(3)(A) of the Act.

[2] Authorized and administered under subsections 5(a)(4) and 5(g)(3)(B) of the Act.

[3] Authorized and administered under subsections 5(a)(5) and 5(g)(3)(C) of the Act.

[4] Subsections 5(a)(2) and 5(g)(3)(a) of the Act.

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to, and to provide for the conduct of training by contract with, public and private agencies and institutions and individuals. The concentration of awards has been for graduate level training programs, considered for a number of years to be the area of greatest need. The Professional Training Grants Program has focused on the development of and the support of students in graduate level programs (primarily at the masters level) in areas relevant to water pollution control. A program for undergraduate training grants and scholarships oriented to the design, operation, and maintenance of treatment plants was initiated recently and is reported in subsection III-C-2-c, below.

Professional training grants are designed to stimulate the development and improvement of graduate programs relating to water pollution control and to support, through traineeships, the graduate students participating in these programs. In this way, the programs produce a cadre of trained professionals prepared to contribute to water quality management through subsequent positions in teaching, research, consulting, or direct operation in staff capacities in the public or private sectors.

Institutions are encouraged to develop specialized and interdisciplinary training programs in order to produce the following kinds of professionals:

--The environmental engineer who is qualified to work in the fields of construction, design, planning, or maintenance of water pollution treatment plants.

--The biologist who is qualified to provide the data needed in the maintenance of approved water quality standards.

--The chemist and the chemical engineer who can improve and devise processes for the more economical treatment of pollutants.

--The lawyer, the economist, and the social scientist who will contribute to the efficient management and planning of water pollution control efforts.

As a general rule, grants are awarded to initiate new and needed programs or to support the expansion of a well-developed program where expansion is warranted on the basis of known major national needs. The grants are used to provide stipends and allowances for full-time preparation for a graduate or postgraduate degree, as well as to expand and improve staff, facilities, and equipment where the training programs are offered.

Grants are awarded annually for one year at a time as part of a training project. The planned project duration is limited to five years and may be renewed subject to application and review, as with the initial application.

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All grant awards are based on the following criteria:

--Mission orientation of program and potential number and orientation of graduates.

--Response to EPA needs and objectives and to overall national manpower requirements.

--Scientific and technical excellence of proposed training program.

--Status of other federally supported institutional programs.

--Probable effectiveness of proposed program.

--Extent of program need in geographic area.

--Adequacy of staff and facilities.

--Competency of staff to teach and conduct research in water pollution control areas.

--Extent of innovation in approaches to curricula development and teaching methods.

--Budget justification for requests.

--Contribution of the institution to facilities and general support of the proposed program.

To ensure that programs will continue to respond to the latest trends and priorities in water pollution control, EPA awarded a grant in FY 1971 to the American Association of Professors in Sanitary Engineering (AAPSE) to help develop revised criteria and guidelines for professional training programs.

An annual review of all projects is made by the EPA Office of Water Programs (EPA/OWP) staff to determine program effectiveness in meeting project objectives. Review of proposed and existing programs is performed jointly by EPA/OWP staff and outside consultants (academicians and research personnel well-known and respected in the field, selected on the basis of their professional and academic standing). This approach has injected new ideas and ensured objectivity in the review process. As part of the review of existing programs, project sites have been visited periodically (approximately every three years) to determine overall effectiveness.

Traineeships[1] supported by Professional Training Grants during FY 1970 to FY 1972 are as follows:

Academic Year	Number Awarded	Amount Awarded
1970-71	788	$3,781,756
1971-72	932	4,562,682

The grants were awarded to institutions and agencies which have ongoing programs in water pollution control and which have been consistently producing graduates to satisfy manpower and training needs in the water pollution control field. Exhibit IV-3 provides a summary of these awards for FY 1970 and FY 1971 by State.[2]

Under these grants, training was provided in the following disciplines:

- Environmental Engineering
- Sanitary Engineering
- Environmental Chemical Engineering
- Environmental Systems Engineering
- Agricultural and Environmental Engineering
- Environmental Mining Engineering
- Nuclear Environmental Engineering
- Soils Environmental Engineering
- Environmental Biology
- Limnology and Aquatic Biology
- Estuarine Biological, Physical and Chemical Oceanology
- Water Chemistry
- Interdisciplinary Environmental Programs
- Environmental Economics

EPA has encouraged the institutions receiving grants not only to develop water pollution control courses within multidisciplinary curricula, but also to consider total environmental needs which may cross

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[1] Traineeships represent the number of trainee-year stipends (that is, full-time, year-long trainee positions). Given a trainee appointment covering an academic year of approximately nine months, the number of students supported generally exceeds the number of traineeships by approximately 30 percent.

[2] A complete listing of these awards by State, institution within the State, and amount awarded appears in the EPA publications, Water Quality Control Training Grants, 1970 and 1971 Grant Awards.

EXHIBIT IV-3
SUMMARY OF PROFESSIONAL TRAINING GRANTS AWARDED DURING FY 1970 AND FY 1971 BY STATE

State	Number of Institutions and Agencies		Number of Awards		Amount Awarded	
	FY 1970	FY 1971	FY 1970	FY 1971	FY 1970	FY 1971
Alabama	2	2	2	2	$ 60,787	$ 103,729
Arizona	1	1	1	1	25,763	46,513
Arkansas	1	1	1	1	44,666	54,861
California	3	5	4	6	213,768	380,086
Colorado	2	2	2	2	109,126	116,621
Connecticut	1	1	1	1	27,974	44,264
District of Columbia	1	1	1	1	43,606	33,236
Florida	1	1	1	1	47,278	106,962
Georgia	1	1	1	1	47,944	37,653
Hawaii	1	1	1	1	27,139	33,157
Illionis	3	4	3	4	156,465	245,041
Indiana	2	2	2	2	111,076	113,363
Iowa	2	2	2	2	81,211	99,204
Kansas	1	1	1	1	37,187	41,368
Kentucky	1	1	1	1	6,447	47,249
Louisiana	1	1	1	1	38,076	38,597
Maine	1	1	1	1	25,602	36,036
Maryland	1	2	1	2	52,782	105,118
Massachusetts	4	5	5	6	218,161	317,325
Michigan	3	3	3	2	264,907	83,415
Minnesota	1	1	2	2	20,834	32,831
Mississippi	1	1	1	1	34,863	44,150
Missouri	2	2	2	1	39,748	99,628
Montana	1	1	1	1	69,582	60,339
Nebraska	1	1	1	1	42,426	40,608
New Jersey	1	2	1	2	47,737	97,372
New Mexico	1	1	1	1	3,623	43,152
New York	4	6	6	8	296,991	286,621
North Carolina	2	2	3	2	97,586	92,622
Ohio	3	4	3	4	100,493	223,719
Oklahoma	2	3	3	4	117,343	151,173
Oregon	1	1	4	2	94,531	86,592
Pennsylvania	3	3	3	3	79,178	127,847
Rhode Island	1	1	1	1	19,166	30,938
South Carolina	1	1	1	2	99,656	116,713
South Dakota	1	1	1	1	23,143	33,750
Tennessee	1	2	1	1	65,816	45,487
Texas	4	4	4	2	268,409	145,336
Utah	2	2	3	3	116,683	138,878
Virginia	1	1	1	0	62,866	10,149
Washington	2	2	3	3	96,492	207,696
West Virginia	1	1	1	1	16,687	28,475
Wisconsin	2	2	6	6	327,938	334,808
TOTAL	72	83	88	91	$3,781,756	$4,562,682

Number of Active Professional Training Grants	FY 1970	FY 1971
States	43	43
Institutions and Agencies	72	82
Grants	89	103

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and combine a number of traditional disciplines. In addition, it encourages them to propose programs in areas of particular local concern; for example, in FY 1971 EPA awarded a grant for development of a program on coastal and estuarine pollution. Similar programs are expected to be introduced in other institutions in the future.

In academic year 1970-1971 (FY 1970 funds), 1,028 individuals received support from professional training grants; in addition, over 2,000 other students took courses that were developed under funding provided by these grants. Renewed and continued Professional Training Grants in the same year supported the participation of 878 trainees, an increase of 19 percent over FY 1969. This increase involved only a 13 percent increase in the amount of funds programmed. This relatively inexpensive increase in trainee participation was achieved largely because the largest portion of investment in faculty, equipment, and curriculum development had been met in previous years.

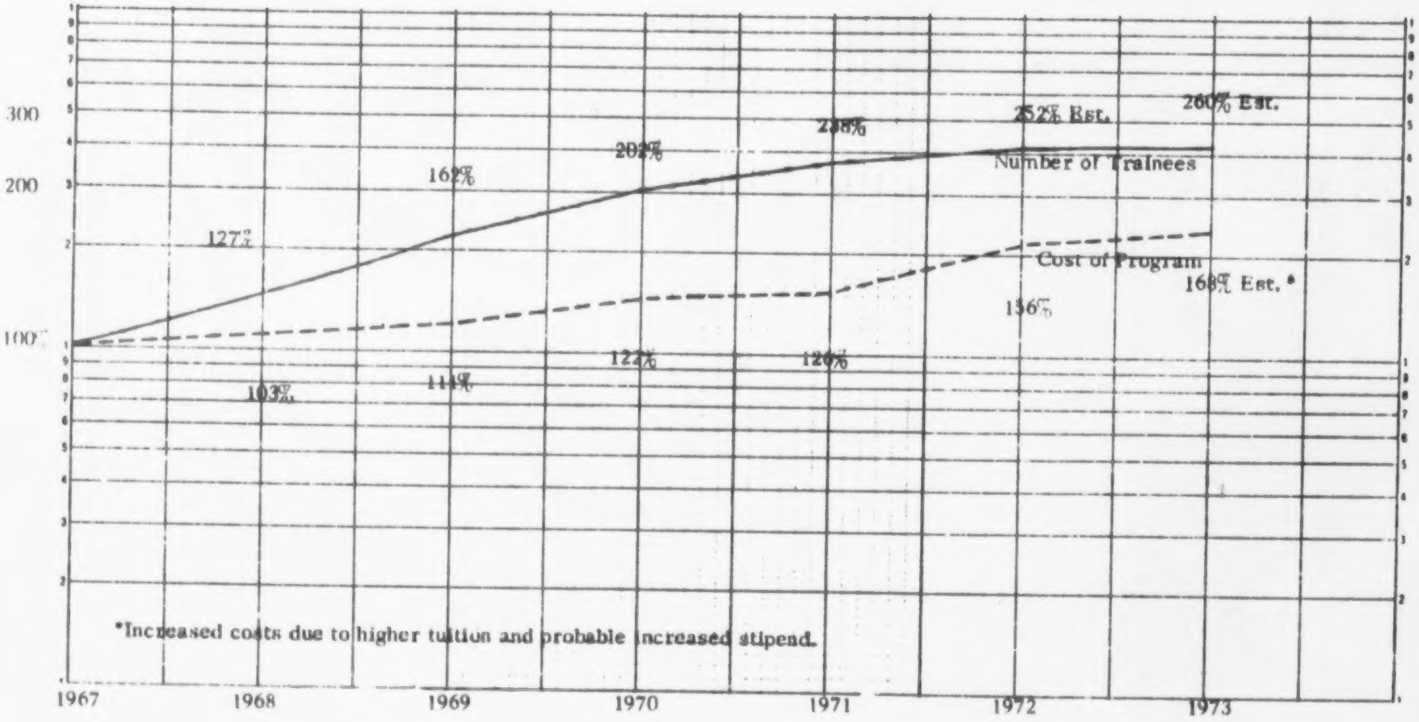
In FY 1970, 12 new professional training grants were awarded, 72 awards were continuations of grants originally awarded within the previous four years, and four were renewals of programs initiated five or more years previously. It is within this latter group that the economy previously mentioned can most often be obtained--increasing the number of trainees with a less than proportional increase in cost.

In academic year 1971-1972 (FY 1971 funds), 91 professional training grants were continued, renewed, or initiated, with emphasis placed on trainee support. These are expected to support a total of 1,051 trainees as compared to 1,028 trainees in FY 1970.

(2) Assessment of the Professional Training Grants Program. The overall effectiveness of the EPA Professional Training Grants Program can be measured by the economies it has produced. The experience of EPA Professional Training Grants Program directors, as well as on-site observation of virtually all of the 103 programs supported at 83 institutions through FY 1971, indicates that initial assistance in faculty support, equipment, acquisition, facilities adaptation, and similar expenditures are essential to provide the base for a new productive training program. The increase in trainee participation has been achieved because the largest part of the investment in faculty, equipment, and curriculum development costs have been met in previous years. (Over 79 percent of the EPA water quality programs are five years old or older.) Expenditures for non-student support over the last six years have been gradually reduced, and presently well over half of the EPA-supported programs spend less than 20 percent on non-student-support items.

Exhibit IV-4 compares the rate of EPA growth of expenditures for program costs with the corresponding rate of growth in number of trainees supported and projected for the six-year period from 1967 through 1972. It demonstrates vividly the multiplier effect resulting from the

EXHIBIT IV-4
COMPARISON OF THE RATE OF GROWTH OF PROFESSIONAL TRAINING GRANT PROGRAM COSTS WITH THE RATE OF GROWTH OF NUMBER OF TRAINEES SUPPORTED (1967-1973)*



*Increased costs due to higher tuition and probable increased stipend.

initial investment and maturation of the supported programs. A more comprehensive view of professional training grant activities over the last decade appears in Exhibit IV-5.

As a result of this buildup of training capability and the maturation of the EPA-financed Professional Training Grant, it now costs approximately 50 percent what it cost in the early 1960's to train a water quality professional. Further, a significant number of students not requiring outside support have been attracted to the field.

Another measure of program effectiveness is the number of graduates who seek and obtain jobs in water pollution control. Less than 3 percent of the manpower trained under these grants have left the field of water quality management. The following table illustrates the broad range of water pollution control sectors entered by 869 graduate trainees whose present position is known:

	Graduate Trainees	
Sector of Employment	Percent	Number
Teaching/Research	19%	166
Private Industry	17	150
Consulting Engineering	27	232
Local Government	5	42
State Government	13	112
Federal Government	19	167
TOTAL	100%	869

A detailed breakdown of job designations of trainees for FY 1963 through FY 1970 appears in Exhibit IV-6.

Finally, the EPA Professional Training Grants Program has primarily national, rather than statewide or even regional, implications. Almost three fifths of the programs draw more than half of their students from outside the State, and about one third draw more than half of their students from outside the region. In over 85 percent of the programs, more than half of the graduates find jobs outside the State, and in 50 percent of the programs the majority of graduates find jobs even outside the region.

EXHIBIT IV-5
PROFESSIONAL TRAINING GRANTS PROGRAM ACTIVITIES
1962-1973

Academic Year	Number of Traineeships Authorized	Number of Trainees Appointed	Number of Professional Training Grants	Number of States Involved	Number of Institutions Involved	Amount Awarded
1972-1973	1,015*	**	**	**	**	$4,650,000*
1971-1972	932	1,051*	91	43	82	4,562,682
1970-1971	788	1,028	88	43	72	3,781,756
1969-1970	633	607	79	39	61	3,201,543
1968-1969	509	522	75	38	60	3,064,997
1967-1968	391	493	71	37	58	2,908,842
1966-1967	323	422	67	36	51	2,499,998
1965-1966	250	336	57	32	42	2,000,000
1964-1965	192	256	54	30	39	2,016,290
1963-1964	114	147	35	19	24	1,100,000
1962-1963	67	79	23	13	16	693,102

*Estimate
**Not Available

EXHIBIT IV-6
JOB DESTINATION* OF EPA-SUPPORTED PROFESSIONAL TRAINEES
(FY 1963 - FY 1970)

Sector	Total		60 Environmental Engineering Programs		13 Biological Science Programs		3 Physical Science Programs		1 Social Science Program		4 Interdisciplinary Programs	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Local Government	42	3	37	3.5	1	1					4	4
State Government	112	8.1	88	8.3	8	4	3	8	1	20	12	13
Federal Government	167	12.1	133	12.5	20	11	3	8			11	11
Consulting Engineering	232	16.8	220	20.7	2	1	2	5			8	8
Industry	150	10.9	129	12.1	8	5	5	13			8	8
Teaching/Research University	166	12	103	9.7	38	21	8	20	2	40	15	16
Teaching in College	38	2.8	14	1.3	24	13						
Teaching in Secondary Schools	11	.8	4	.4	5	3					2	2
Military Service	149	10.8	121	11.4	11	6	3	8	1	20	13	14
Left Field of Water Quality	36	2.6	30	2.8	5	3					1	1
Unknown	99	7.2	62	5.8	23	13	2	5			12	13
Further Education	178	12.9	121	11.4	33	19	13	33	1	20	10	10
Total	1380	100.0	1062	99.9	178	100	39	100	5	100	96	100
Pipeline (supported as of 30 June 1970)	448	100	297	66.2	73	16.2	21	5	6	1.3	51	11.3
Grand Total	1828	100	1359	74	251	14	60	3	11	1	147	8

*All known permanent positions are water-quality-oriented with the exceptions of "Left Field of Water Quality" and possibly three Local Government, seven State, 23 Federal, 11 Secondary School Teaching, and 10 Industry positions which may not be so oriented. Total 90 or 6.5 percent maximum, 2.6 percent minimum left the field, primarily to go into air pollution or solid waste jobs.

b. The Research Fellowship Program

(1) Scope and Activities of the Research Fellowship Program. EPA is also authorized[1] to establish and maintain research fellowships. These fellowships are provided primarily to increase the number and competence of scientists and engineers qualified to conduct independent research and advanced practice in water pollution control problems, in conjunction with teaching at the graduate professional level. The awards, which are nationally competitive, are made primarily to candidates for the doctoral degree in the engineering, physical sciences, biological sciences, or socioeconomic disciplines. (About 75 percent of the research fellows normally go into teaching or research.)

Fellowship awards are based on the following criteria:

--Purpose of the study and objectives to be achieved; research method.

--Relevance of training background to water pollution control.

--Academic standing.

--Credentials of the institution and sponsor under which the study is to be performed.

Applications for this program are reviewed with the objective of selecting the most promising students. The stringency with which applications are reviewed is reflected in the fact that, in recent review sessions, only about one third of those applications submitted were considered acceptable by EPA.

In both FY 1970 and FY 1971, the EPA Research Fellowship Program was funded for $600,000. In FY 1970, it provided 105 fellowships at 51 institutions and agencies in 29 states and in four foreign countries; in FY 1971, it provided 108 fellowships at 58 institutions and agencies in 27 states and six foreign countries. Exhibit IV-7 provides a summary of these awards, by state.[2] A view of research fellowship activities over the last decade appears in Exhibit IV-8.

Expectations for FY 1972 are that 44 to 55 new fellowships will be awarded, 45 to 60 will be renewed, and 50 to 60 will be continued.

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[1] Subsections 5(a)(4) and 5(g)(3)(B) of the act.

[2] A complete listing of these awards by State, institution within the State, and amount awarded appears in the EPA publications, Water Quality Control Training Grants, 1970 and 1971 Grant Awards.

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EXHIBIT IV-7
SUMMARY OF RESEARCH FELLOWSHIPS AWARDED DURING FY 1970 AND FY 1971, BY STATE

State	Number of Institutions and Agencies		Number of Awards		Amount Awarded	
	FY 1970	FY 1971	FY 1970	FY 1971	FY 1970	FY 1971
Alabama						
Arizona		1		1		$ 6,600
Arkansas						
California	2	4	5	9	$ 27,257	52,412
Colorado	2	2	3	3	11,400	12,440
Connecticut						
District of Columbia						
Florida	1	1	2	3	12,600	17,000
Georgia						
Hawaii						
Idaho	1		*		*	
Illinois	2	2	6	3	35,800	6,433
Indiana	3	3	3	6	16,600	30,100
Iowa	2	2	4	4	29,086	22,067
Kansas						
Kentucky						
Louisiana	1		*		*	
Maine						
Maryland		1		1		5,100
Massachusetts	4	4	5	3	26,564	24,355
Michigan	4	2	12	8	63,911	39,108
Minnesota	1	1	1	2	5,100	10,400
Mississippi						
Missouri	1	2	3	5	19,134	24,250
Montana	1	1	3	3	17,000	18,200
Nebraska						
New Hampshire	1	1	2	1	12,816	5,367
New Jersey	1	1	6	2	32,053	8,000
New Mexico	1		*		0	
New York	4	5	9	14	40,437	66,743
North Carolina	2	2	2	3	16,150	18,124
Ohio	1		*		0	
Oklahoma	2	2	1	2	7,100	12,400
Oregon	1	1	1	2	5,889	10,400
Pennsylvania	1	4	8	5	41,886	24,350
Rhode Island	1	1	1	2	5,600	11,768
South Carolina	1	1	1	3	6,660	17,800
South Dakota						
Tennessee						
Texas	2	2	5	5	29,800	36,945
Utah	2	2	4	3	21,400	19,467
Virginia	1	1	1	1	5,100	5,300
Washington	3	2	3	2	20,162	14,100
West Virginia						
Wisconsin	2	1	12	8	60,515	51,073
Foreign	4	6	3	4	29,980	29,698
TOTAL	51	58	105	108	$600,000	$600,000

*Continued with no additional funds.

Number of Active Research Fellowships	FY 1970	FY 1971
States	29	27
Institutions and Agencies	51	58
Fellowships	149	161

EXHIBIT IV-8
RESEARCH FELLOWSHIP PROGRAM ACTIVITIES
1962-1973

Academic Year	New Research Fellowships Authorized	Total Research Fellowships Awarded	Number of Active Fellows	Number of States Involved	Number of Institutions Involved	Funds Awarded
1972-73	50*	105*	155*	28*	56*	$600,000*
1971-72	46	108	161	27	58	600,000
1970-71	60	105	149	29	51	600,000
1969-70	46	91	168	29	51	592,094
1968-69	53	113	155	28	48	632,991
1967-68	47	103	147	24	46	622,411
1966-67	39	113	115	29	55	709,999
1965-66	48	101	145	28	51	616,715
1964-65	48	75	102	24	38	472,096
1963-64	40	45	64	25	37	269,019
1962-63	25	25	25	16	18	97,938

*Estimated

(2) Assessment of the Research Fellowship Program. Overall effectiveness of the Research Fellowship Program is reflected by its function as the primary source of instructors for university training of professionals and the primary mechanism for building the capacity for research and training for professionals.

c. The Direct Technical Training Program

(1) Scope and Activities of the Direct Technical Training Program. In addition to its other programs, EPA is authorized[1] to "provide training in technical matters relating to the causes, prevention, and control of water pollution to personnel of public agencies and other persons with suitable qualifications." Under this authority, EPA provides its own program of direct training and related supportive activities to supplement the technical activities of others.

The EPA Direct Technical Training Program is directed to key Federal, State, local, and private personnel who hold responsibility for evaluation, prevention, abatement, and control of water pollution. Its purpose is fourfold:

- To provide a continuing, comprehensive program of specialized and advanced technical training generally unavailable elsewhere.
- To research and develop instructional technology, and to provide an instructor development program for individuals responsible for and/or conducting environment training or related activities.
- To provide, on request, instructors and/or training materials in support of the training programs of other Federal, State, and local agencies.
- To develop new training delivery methods, curricula, and materials, such as for use in correspondence courses.

Most direct training consists of short-term seminars, workshops, and courses of one- to two-weeks'dduration. These courses are conducted by a highly trained and experienced staff of EPA professionals[2] at four regional centers and one national training facility:

--Robert S. Kerr Water Research Center; Ada, Oklahoma.

--Southeast Water Laboratory; Athens, Georgia.

--National Training Center; Cincinnati, Ohio.

--Pacific Northwest Water Laboratory; Corvallis, Oregon.

--Edison Water Quality Laboratory; Edison, New Jersey.

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[1] Subsections 5(a)(5) and 5(g)(3)(C) of the Act.

[2] Some instructors are drawn from elsewhere, including universities.

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A limited number are also given in field locations by special agreement with EPA.

The training programs are primarily oriented to professionals, although they are also available to subprofessionals in the water pollution control field. Specific training objectives include:

--Broadening or improving the professional skills of experienced personnel.

--Providing specialized and basic skills for professional and technical personnel recruited into water pollution control from other fields.

--Assuming rapid application of new research findings in the field of water pollution control.

At present, a major problem in fully achieving the designed efficiency and effectiveness of existing pollution control facilities is that many of the operating personnel are underskilled and undertrained. Many of the short courses conducted under the Direct Technical Training Program concentrate on upgrading the skill levels of these employees, thus improving the operations of present abatement systems.

The courses given provide either overview summaries of the concepts, science, and techniques for abating and preventing pollution, or detailed reviews of new technological developments, operational methods, and research findings. They also address specific practical features of wastewater treatment design and operation, water quality evaluation in field and laboratory, and technical and administrative aspects of water quality management and water pollution control.

IN FY 1971 the OWP conducted 37 scheduled short-course training programs. Additionally, it provided 22 special, unscheduled courses or workshops to satisfy specific training requirements of local, State, or Federal agencies. The total number of persons trained between April 1970 and September 1971 is shown in Exhibit IV-9 by water pollution control sector, occupation, and training site. The percentage of persons trained between FY 1969 and FY 1971 is shown in Exhibit IV-10 by water pollution control sector, educational level, and occupation.

In 1972, EPA plans to expand its Direct Technical Training Program in water pollution control in three specific areas:[1]

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[1] Courses to be presented in 1972 are listed in the catalog, Education and Training Programs, EPA, OWP, July 1971-June 1972.

EXHIBIT IV-9
NUMBER OF PERSONS TRAINED UNDER EPA DIRECT TECHNICAL TRAINING PROGRAM, BY WPC SECTOR AND OCCUPATION
(April 1970-September 1971)

		EPA TRAINING FACILITY					
		Cinn.	Ada	Athens	Corvallis	Edison	Total
1.	Number by WPC Sector						
	EPA	228	6	44	33	31	342
	D. Defense	80	8	10	41	43	182
	Other Federal	87	8	63	237	48	443
	State	157	48	92	108	33	438
	Local	114	2	28	81	17	242
	Foreign Gov't.	43	2	0	11	5	61
	Univ. Faculty	40	2	12	33	3	90
	Univ. Student	11	0	5	24	2	42
	Industry	141	4	10	24	14	193
	Consultant	39	0	6	6	6	57
	Regional Agency	11	0	0	4	4	19
	Other	16	1	2	8	0	27
	TOTAL	967	81	272	610	206	2,136
2.	Number by Occupation						
	Administrator	34	9	13	16	55	127
	Biologist	86	18	52	85	14	255
	Chemist	154	7	43	42	20	266
	Conservationist	1	1	0	9	0	11
	Educator	22	1	1	11	2	37
	Engineer	374	22	88	157	67	681
	Geologist	2	5	11	8	2	28
	Microbiologist	20	3	0	22	1	46
	Oceanographer	2	0	2	4	2	10
	Pharmacist	0	0	0	1	0	1
	Sanitarian	17	1	9	27	7	61
	Statistician	5	0	1	1	1	8
	Technician	79	6	9	61	13	168
	Treatment Plant Operator	38	0	9	60	0	107
	Other	160	8	34	106	22	330
	TOTAL	967	81	272	610	206	2,136

EXHIBIT IV-10
PERCENTAGE OF PERSONS TRAINED UNDER EPA DIRECT TECHNICAL TRAINING PROGRAM, BY WPC SECTOR, EDUCATIONAL LEVEL, AND OCCUPATION
(FY 1969-FY 1971)

	FY 1969	FY 1970	FY 1971
TOTAL STUDENTS	1,297	1,480	1,630
1. WPC Sector			
Federal	48%	40%	47%
State-Local	32	36	32
Educational Institutions	4	7	8
Industry-consultants	11	9	11
Foreign	4	4	?
Others	1	4	2
2. Educational Level			
Less than College	10%	8%	11%
College, Nongraduate	10	10	11
College, Graduate (B.S., B.A.)	51	50	49
Masters	23	26	24
Ph.D.	5	5	5
3. Occupation			
Engineer	38%	32%	30%
Biologist-Microbiologist	16	17	14
Chemist	14	17	12
Technician	8	8	8
Treatment Plant Operator	8	4	7
Administrator	4	4	6
Sanitarian	3	8	3
Other	9	10	20

- --Development of self-sufficient training facilities, within the five training centers, to provide learner-centered instruction. Training facilities will ultimately contain 20 to 30 individual booths, each with its own audiovisual equipment, manuals, workbooks, programmed teaching slides, tapes, and filmstrips.

- --Formation of mobile training teams to provide training courses to reach small, isolated treatment plants nationwide.

- --Initiation of a correspondence training program. The development of material for this program will complement the materials for learner-centered training and will provide a wide variety of subject matter for individual study.

Additionally, the number of short courses will be expanded, and courses will be offered in regions that lack a permanent training facility. Federal personnel who will be working with programs related to State and local agency activities will form the single largest group of participants. State and local agency personnel will form the next largest group.

EPA estimates that the breakdown between classroom students and those participating in correspondence courses will be as follows:

Number of Students	Fiscal Year 1972	1973	1974	1975	1976
Classroom	2,000	2,330	2,800	2,820	3,000
Correspondence	370	450	520	530	600
TOTAL	2,370	2,780	3,320	3,350	3,600

EPA also supports State training programs for professionals, technical, and operator personnel--on request--through technical consultation on the planning and development and dissemination of training courses. In addition, the agency arranges for guest appearances of instructors and provides instructional materials such as training manuals, course plans, and audiovisual training aids.

(2) Assessment of the Direct Technical Training Program. The ultimate measure of effectiveness of a training program, of course, is the degree of increased productivity of the trainees upon return to their work environment. This factor has been particularly difficult for EPA to determine because of staffing limitations for follow-up and evaluation activities.

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The effectiveness of the Direct Technical Training Program can be measured in other ways, however. First, the training provided through scheduled and unscheduled (special) workshops, seminars, and short-term courses has increased in volume during the last three years. This increase has been accomplished within restrictive funding and an actual reduction in available instructor man-hours. The increase in the number of courses presented and the number of students attending since 1969 is as follows:

Year	Courses	Students
1969	45	1,297
1970	57	1,560
1971	59	1,630

Second, there has been a steady increase in requests by local, State, and Federal agencies for professional assistance and instructional materials to satisfy their specific training needs. As indicated above, over 22 of these special courses were presented during FY 1971.

Third, several training innovations have been introduced. During 1971, EPA produced and pilot-tested a correspondence course on "Membrane Filter Techniques." It also prepared other innovative training materials (including course manuals, films, and videotapes) for use by its regional training facilities and by others outside EPA.

d. The Technology Transfer Program

(1) Scope and Activities of the Technology Transfer Program. Investment in research and development over the past few years has realized significant improvements in water pollution control technology. One of EPA's major concerns has been the development of programs which will permit maximum utilization of these advances. EPA recently launched a Technology Transfer Program intended to bridge the gap between research, development, and demonstration and implementation of results. Although its scope extends to all media and categorical programs, its orientation to water pollution control has been to make known the potential of both technology presently available and new technology as it is developed, in order to influence (i) prevention, detection, and clean-up techniques and (ii) design, installation, and operation of old and new wastewater treatment facilities. To date, the program has been primarily geared to transferring newly developed technology in the field of municipal water pollution control.

The primary objective of the municipal water pollution control technology transfer effort has been to have an immediate impact on the Construction Grants Program to prevent a major national investment in traditional wastewater treatment facilities that no longer offer the effectiveness, efficiency, or flexibility to meet present and future water quality standards and requirements. A longer term objective is to establish firmly the newly emerging technologies as practical and feasible alternatives, on a national basis, to be routinely considered and evaluated in the planning of wastewater treatment facilities. This objective encompasses the future inclusion of these technologies in the undergraduate and graduate curricula of our educational institutions.

To achieve its immediate primary objective, the Technology Transfer Program has been directed to the following target groups, listed in order of their importance:

--Municipal, State, and private consulting design engineers.

--Public administrative decision-makers with water pollution control policy responsibilities (such as mayors, councilmen, directors of public works, and city managers).

--Conservation groups and the general public.

Each of these groups is discussed below.

(i) Design Engineers. Because the design engineers will put the new technology on the drawing boards, they have been identified as the priority target audience. The actual type of technology to be used in treatment facility design emanates in almost all instances from the municipality's

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consulting engineers. Review and acceptance of the design is normally a function of government staff engineers at both the municipal and State levels. All of these engineers must be effectively convinced that the new technologies are now practical and feasible--economically and technically--and ready for immediate full-scale use. Without acceptance by the engineering profession, the delay in bridging the gap between research and demonstration and full-scale implementation will stretch over many years.

(ii) Public Decision-Makers. Public decision-makers have traditionally relied almost completely on their consulting engineers for selection of appropriate wastewater treatment processes. They must now have knowledge as to the new treatment alternatives and economies that are rapidly becoming available. This knowledge will then become a key factor in evaluating recommendations by consulting engineers and overcoming the reluctance of both engineers and public officials to initiate new treatment technology. In many smaller municipalities, a generalized knowledge of available technology by public officials will be the only factor to overcome reluctance of smaller, less advanced consulting engineering firms to make a commitment to new technology.

(iii) Conservation Groups and the General Public. A nontechnical knowledge of available technology by these groups allows more informed decisions by the public for bond issues, tax increases and other issues.

The transfer of technology is a complex process requiring close coordination and collaboration among all elements of the EPA/OWP organization, and particularly between the research and development and the manpower training and development functions. The technology must first be researched and extracted, then structured for dissemination to varying audiences with varying needs, and finally actually disseminated. The EPA Technology Transfer Program approaches the dissemination of technology in two ways:

- Through "general awareness" training (that is, making known the fact that the technology is available) accomplished by means of briefings, seminars, newsletters, and so forth.

- Through "detailed knowledge" training (for those who will need to apply the technology) accomplished by short-course training.

So far, EPA has established mechanisms for providing general technological awareness training which are summarized below. It also intends to develop mechanisms for introducing detailed knowledge training into its Direct Technical Training Program and into the curricula of existing programs outside EPA.

Major activities to date in the municipal wastewater treatment area include:

--Presentation of two-day technical workshop/seminar programs for State, municipal, and private consulting engineers involved in the design of wastewater treatment facilities. Design seminars emphasizing the practical application of new technology (design criteria and parameters, capital and operating costs, results of research demonstrations, and experience and problems) were held between February and September 1971 in six EPA regions. Format of the program varied according to regional needs, determined in cooperation with the State water pollution control agencies. Future seminars are scheduled on a monthly basis, with each EPA region having at least one seminar before the end of 1971.

--Development of design manuals for consulting engineers. All of the technical experience, data, and criteria evolving from the research and demonstration programs are being extracted from research reports and consolidated into design manuals which will enable the consulting engineer, for the first time, to receive complete and comprehensive design information. The lack of such publications in the past has been a major factor hindering widespread use of technology. Four design manuals (on phosphorous removal, granular carbon adsorption, upgrading existing treatment plants, and suspended solids removal) have been completed thus far and will be distributed nationally.

--Monitoring of approximately 60 demonstration grant projects throughout the country for technology transfer applicability, timing, and methods.

--Development of visual media presentations. Technical videotape presentations have been planned for use by EPA regions in introducing newly available technologies. One (on granular carbon adsorption) has been completed and three more are currently under way. In addition, a brief, nontechnical motion picture on phosphorous removal, intended for showing to public officials and conservation groups, is nearly completed, as is a motion picture exploiting an EPA phosphorous removal demonstration project at Richardson, Texas, to be used during both technical and semitechnical presentations.

Another motion picture featuring a relocatable advanced waste treatment plant is under way.

A technimated display booth describing the Technology Transfer Program is currently being used in various areas of the country. Additional booths on phosphorous removal, upgrading existing plants, and physical-chemical treatment have also been completed.

Many publications, in addition to the design manuals discussed above, are now available, under preparation, or being planned. These include technical brochures, newsletters, and a wide variety of technical publications prepared for the design seminars.

Plans are under way to conduct regional seminars for administrative decision-makers in water pollution control (such as city managers, public works directors, city councilmen, county commissioners, and heads of municipal and State water pollution control agencies). These workshops will be aimed at convincing responsible administrators that new technology is available for full-scale application and that it can be used effectively to meet water quality standards. As in the design seminars, these workshops will be slanted toward the specific technology needs of each region. EPA will also conduct a campaign to create public awareness through special programs directed toward students, conservation associations, civic groups, and so forth. Further, technical bulletins will be issued to supplement the Federal Design Guidelines published in October 1970.

(2) Assessment of the Technology Transfer Program. While results of this program can be assessed only over the long term, preliminary indications of program effectiveness are favorable. For example, the seminars for consulting engineers involved in the design of wastewater treatment facilities have been well received by the engineering community and by various professional organizations. EPA has received a flood of correspondence from consulting engineering firms, industries, and State and municipal engineers requesting technical information since the publication of several articles in technical journals briefly describing the Technology Transfer Program. Further, EPA technical personnel have made on-site visits in response to municipal and State requests for information on new technologies. These requests undoubtedly will increase as the program expands and becomes more widely known, thus establishing an effective dialogue between EPA and the engineering community.

The need for the Technology Transfer Program is obvious, and its value can be recognized as the initial mechanism for transferring the Federal Government's research investment to the practitioner. However, this program is only the first step in the transfer of new technologies. The technology presented to selected target groups provides the base for specific training courses designed to accommodate a more varied audience with needs for greater detail in both concepts and techniques.

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e. Conclusions Regarding EPA Training for Professionals. The Professional Training Grants and Research Fellowships Programs provide a nucleus of trained professional manpower in many disciplines at many degrees of professional competence to be applied to the control of water pollution. Over the years, these programs ". . . largely have been responsible for the reservoir of scientific and engineering manpower now available in the field of water pollution control."[1]

Indeed, virtually all of the graduate-level programs related to water pollution control are supported by EPA. This support has been pointedly oriented to water pollution control, as distinct from the more general orientation of support from other Federal agencies. Programs have been developed, wherever possible, to deal with the practical problems of operations and management.

The Professional Training Grants Program is the primary source of funding for the preparation of professionals entering the field of water pollution control. Since most of the recipients under the Research Fellowship Program continue thereafter in research or teaching, EPA, in a sense, is making a capacity-building investment to produce future graduate professionals to enter the field of water pollution control.

The Direct Technical Training Program is essentially the only existing program that provides updating courses for professionals (and others) and thereby fills a major gap in professional training activities. It supplements the rather limited upgrade training activities of others. With the Technology Transfer Program, it provides a mechanism for transmitting rapidly the results and application of new research findings. EPA's supportive activities offer the potential to broaden the coverage of technical update and upgrade training and to improve the capacity of others to increase their penetration and coverage.

In sum, these programs help satisfy two distinct needs for professional training that are not otherwise satisfied by the other sectors: (i) primary financial support for entry training and (ii) direct programs and support for update and upgrade training. Nevertheless, as indicated in Part II, the quantitative needs exceed the capacity of EPA and others to respond.

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[1] Robert A. Canham, Executive Secretary, Water Pollution Control Federation, Statement to the Subcommittee on Agriculture Environmental and Consumer Protection of the House Appropriations Committee, 5 May 1971.

2. EPA Training for Operators and Technicians

As discussed in Section III-B, above, it is meaningful to distinguish among those elements of the work force who are in positions at the lower levels of operations as opposed to those at the higher levels. This distinction is maintained in the following report on EPA training activities for operators and technicians.

For entry and upgrade training of lower level operators, EPA has collaborated with the Department of Labor (DOL) and the Department of Health, Education, and Welfare (HEW), in negotiating and administering national MDTA-funded contracts and has encouraged the states and localities to do likewise.

To overcome the limitations of these and other programs, to provide an alternate mechanism for the upgrading of existing operators and technicians, and to help build the capacity of others to do likewise, EPA initiated a Pilot Program[1] of projects designed for this purpose.

Finally, to respond to the undercapacity of educational institutions to prepare undergraduate students to enter the water pollution control field as technicians or upper level operators, EPA initiated an Undergraduate Training Grants and Scholarship Program.[2]

Each of these programs is designed to overcome the limitations of others whose training activities have not fully met the entry or upgrade training needs for water pollution control operators and technicians. The following report and assessment of EPA's activities will be followed by conclusions as to EPA's responsiveness to these unmet needs.

a. National MDTA-Funded Contracts. During the last two years, EPA established, in cooperation with the Departments of Labor and Health, Education, and Welfare, four training programs in waste treatment plant operations intended to fill the gap in lower level operator and technician training at the State and local levels. These programs, which are designed to bring trainees into the water quality field or to develop and increase their existing skills, include:

- Coupled On-the-Job Training
- Institutional Training
- Public Service Careers
- Transition Training

All four are supported by funds available under the Manpower Development and Training Act and are administered through Interagency Agreements by the EPA Office of Water Programs. Subcontracts are awarded by EPA to units of State government, municipalities, special wastewater treatment districts, vocational schools, community colleges, and universities. These programs, which are summarized in Exhibit IV-11 are discussed below.

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[1] Authorized by subsection 5(g)(1) of the Act.

[2] Authorized by sections 16 and 18 of the Act.

Additionally, EPA works with State and local agencies to help them qualify for MDTA support, arranges training for instructors, provides teaching materials and curriculum development assistance, and otherwise assists State and local governments in getting training projects under way.

(1) Coupled On-the-Job Training

Scope and Activities of the EPA Coupled OJT Program. This program offers entry-level and upgrade operator training for the unemployed and underemployed in wastewater treatment plants through combined classroom and on-the-job training tailored to meet operational realities. Unlike traditional DOL programs, which provide training in a single facility, the national Coupled OJT Program established by EPA uses a twofold approach to training. Twenty-five percent of the subcontracts were awarded directly to large municipal wastewater treatment plants for the provision of centralized training; the balance were awarded to cities, community colleges, or councils of government to serve a number of treatment plants within the surrounding communities for the provision of decentralized training.

Under the decentralized approach, classroom instruction is given in one plant--during or between working hours, depending on the plant environment. Over-the-shoulder OJT is provided by the classroom instructor (who must have operational knowledge) in the plant where the trainee is employed. To eliminate gaps in coverage, two correspondence courses and audiotapes are available for self-study at home.

As noted in subsection III-B-3-c, similar MDTA-funded programs were managed by a number of State water pollution control agencies in FY 1971. The national program sought to assist those states without OJT programs and to supplement the existing programs, which were just under way and on a much smaller scale.

Initially, the program focused on improving the skills of operators already in place and, in turn, upgrading plant operations. Its objectives were to help trainees meet certification requirements and to reduce turnover and stabilize the existing work force. The first national contract (effective January 1969 - October 1970) required that 10 percent of all trainees be new entrants and that the remainder be employed in a treatment plant prior to attending the program.

The length of the training course was 44 weeks and consisted of 330 hours of classroom instruction and at least 70 hours of over-the-shoulder OJT for each trainee. The first 100 hours of classroom instruction were normally devoted to basic courses in varied subjects such as mathematics, biology, and chemistry, which would help the trainee during the following 230 hours of job-related courses and 70 hours of over-the-shoulder OJT.

The initial program was able to demonstrate that the MDTA funding mechanism works. Out of 1,055 trainees, 936 successfully completed the course. As a result of the program, the average trainee's salary increased from $7,600 to $8,600. The average increase was 13.2 percent, with the maximum individual trainee increase being 35.2 percent. Ninety-seven percent of all trainees in the program received some type of salary increase.

Of the 1,055 trainees enrolled, 81.2 percent successfully completed the course, with 93 percent of those passing the certification examination at the certification level for which they were permitted to test. Because a number of State certification agencies were persuaded to evaluate the course and to allow credit for completion, many trainees also received a higher level of certification and thus had a more advantageous position in the labor market. California and Iowa, for example, allowed the equivalent of one year's experience toward a higher level of certification. In addition, many trainees gained high school equivalency diplomas. The State of Washington granted one year of college equivalency, and the Metropolitan Sanitary District of Greater Chicago granted four years' experience credit for completion of the 44-week course.

The training was well received and highly praised by State and local officials and by plant operators, who indicated that motivation on the job was noticeably increased among operators who had participated in the training. At the start of the program, the employers were asked to rate the trainees' motivation. The results showed that only 15.3 percent were highly motivated at the beginning of the training. Upon completion of the training, the employers indicated that 65.4 percent were highly motivated.

The trainees themselves have given the program a high rating, according to a study recently completed by the University of Virginia and the Office of Water Programs under the auspices of EPA.[1] The study team surveyed operators at more than 80 percent of the ongoing training centers between June and December 1970. It reported that 97 percent of the respondents felt that the training was "worth it," 98 percent felt that the course should be continued, and 92 percent felt that they could improve or assist in improving the efficiency of their plants as a result of the training.

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[1] Sewage Treaters or Pollution Controllers?: Trainees View Their Jobs, C.F. Longino, Jr., and C.S. Green III, University of Virginia; C.F. Kauffman, Environmental Protection Agency, Office of Water Programs, undated.

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Not only do the trainees rate EPA programs as excellent, but in the annual State Program Plans, the State agencies speak very well of them. California, for example, stated, "There should be more and larger programs such as the one EPA has just sponsored here in California." The California subcontract was administered by the Water Quality Board for entry and upgrading of wastewater treatment plant operators.

Based on the success of the initial program, which cost $1,031,-775, the second national coupled OJT contract (effective November 1970 - April 1972) was awarded to train 1,000 persons at a cost of $1,260,000. The program under this contract represents a refinement of the initial training course in two major ways:

--To increase the labor pool of wastewater treatment plant personnel 30 percent of the enrollees are new entrants (rather than the 10 percent originally required).

--To be responsive to local conditions and needs, training time is optional. Duration of training varies from 24 weeks (two courses with 10 trainees each) to 48 weeks (one course with 20 trainees), but all trainees receive essentially the same number of hours of classroom instruction and OJT.

As of September 1971, 480 persons had completed training under the second contract, and 558 are presently enrolled.

Summaries of the first and second national coupled OJT contracts are included in Exhibit IV-11.

Assessment of the EPA Coupled OJT Program. As discussed previously, many graduates of the first national Coupled OJT Program received promotions, earned higher salaries, and passed certification examinations. In addition, many earned high school equivalency certificates and college credits. The second national program is still under way, but monitoring reports indicate an even higher level of success for the second program.

A major strength of the program has been its mobility in reaching out to the small wastewater treatment plant through decentralized OJT and its introduction of the classroom instructor into the treatment plant for program coordination and continuity. One problem encountered with this approach has been the resistance of some employers to the provision of OJT by the classroom instructor--an "outsider"--rather than by a representative of the plant. These employers have expressed concern that the OJT instructor's role would be one of a critic--without knowledge of or sensitivity to the particular plant environment. For the most part, this resistance has been overcome through demonstration of the instructors' capability to provide objective training and through their in-depth knowledge of wastewater treatment plant operations.

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EXHIBIT IV-11
SUMMARY OF NATIONAL MDTA-FUNDED CONTRACTS

A. Summaries of First and Second National Coupled OJT Contracts

Resume of the First National Coupled OJT Contract

Date contract was signed	21 January 1969
Termination date	31 October 1970
Total Amount of Contract	$1,031,775
DOL portion	645,640
HEW (Office of Education) portion	386,135
Total Number of Trainees starting program	1,055
Total Number of Trainees completing program	936

Training started in Butler, Pennsylvania, in May 1969

Sponsor Subcontractor	Trainees Entered	Trainees Completed	Training Location
Pennsylvania (State)	78	70	Phila., Penn Hills, Bethel Park, Butler, and Meadville
St. Louis, MO (Metro Dist)	26	18	St. Louis
Detroit, MI (Metro Dist)	39	36	Detroit
Des Moines, IA (City)	23	23	Des Moines
North Central Texas (C.O.G.)	52	52	Houston and Dallas
Indianapolis, IN (Voc School)	20	15	Indianapolis
South Bend, IN (Voc School)	22	18	South Bend
Omaha, NB (City)	28	17	Omaha
Lexington, KY (Univ. of KY)	42	40	Lexington
Seattle, WA (City)	20	19	Seattle
Lafayette, IN (Voc School)	42	25	Lafayette
West Virginia (University)	49	41	Charleston and Athens
Ft. Lauderdale, FL (City)	20	15	Ft. Lauderdale
Southern Illinois University	24	22	Edwardsville, IL
Louisiana (State)	23	23	New Orleans
California (State)	142	133	Sacramento, Santa Barbara, Santa Rosa, Orange County
Northwest Arkansas (C.O.G.)	23	23	Fayetteville
Maryland (State)	55	52	Charles County, Hagerstown
Denver, CO (Metro Dist)	24	21	Denver
Houston, TX (University)	38	30	Houston
Chicago, IL (Metro Dist)	44	33	Chicago
Portland, OR (City)	42	41	Portland
Cleveland, OH (City)	28	26	Cleveland
Gary, IN (Voc School)	24	21	Gary
Ann Arbor, MI (Community College)	23	23	Ann Arbor
New York, NY (City)	20	17	New York
Rockland County, NY (Sewer Dist)	18	18	Rockland County
Pensacola, FL (City)	28	28	Pensacola
St. Louis, MO (City)	48	36	St. Louis

EXHIBIT IV-11 (Cont'd)

Resume of the Second National Coupled OJT Contract

Effective date	2 November 1970
Termination date	30 April 1972
Total Amount of Contract	$1,260,000
Total Number of Trainees under Contract	1,000

Sponsor/Subcontractor	No. of Trainees	Starting Date	Training Location
[illegible] (City)	40	11/2/70	Omaha, NB
[illegible] University	20	11/2/70	Edwardsville, IL
[illegible] Water Resources [illegible]	100	11/2/70	Santa Barbara, Visalia, Santa Rosa, Orange Coast
[illegible] Air Pollution [illegible] Authority	20	7/1/71	Greenville, SC
[illegible] Institute	20	11/2/70	Lafayette, IN
[illegible] Community College	60	11/2/70	Cumberland, LaPlata, Baltimore, MD
[illegible] Texas C.O.G.	40	11/2/70	Arlington, TX
[illegible] Regional Planning [illegible]	20	12/1/70	Fayetteville, AR
[illegible] Technical Institute	20	11/2/70	Indianapolis, IN
[illegible] of Kentucky	60	2/18/71	Lexington, KY
Metro. [illegible] Commission	20	12/7/70	Kansas City, MO
Portland, OR (City)	40	11/9/70	Portland, OR
North Dakota State Dept. of Health, Div. of Water Supply & Poll. Control	40	1/4/71	Devils Lake, Minot, Bismarck, ND
North Carolina State Dept. of Water & Air Resources	40	6/1/71	
Utah Division of Health	20	1/4/71	Salt Lake City, UT
Florida Division of Health	20	1/15/71	Ft. Walton Beach, Miami, FL
Northwest Technical Institute	20	11/2/70	Gary, IN
Louisiana Dept. of Health	20	3/15/71	New Orleans, LA
West Virginia University	20	4/19/71	Parkersburg, WV
St. Joseph Valley School	20	3/2/71	South Bend, IN
DC Dept. of Sanitary Engineering	20	4/1/71	Washington, D.C.
New Mexico Health and Social Services Dept.	20	4/19/71	Las Cruces, Silver City, NM
Metro. Sewer Board	20		St. Paul, MN
Rockland County Sewer Dist. #1	20	3/3/71	New City, NY
Mississippi Air & Water Pollution Control Commission	20	3/15/71	Hattiesburg, MS
Nevada Dept. of Health, Welfare and Rehabilitation	20	3/15/71	Carson City, NV
Connecticut Department of Labor, Employment Service	40	6/28/71	
Community College of Denver	20	6/1/71	Denver, CO
Metro. Sewer District of Greater Chicago	40	6/1/71	Chicago, IL
Dept. of Public Works, VI	20	5/24/71	Virgin Islands
[illegible], College of Engineering, Brookings, SD	20		
State Dept. of Health, Helena, MT	20	7/12/71	Helena, MT
[illegible] Dept. of Education	20	7/1/71- 1/27/72 10/31/71- 4/30/72	Harrisburg, PA
Miami-Dade Junior College	20-25	10/4/71	Miami, FL
Junior College District of College Newton and McDonald Cos.	20	7/19/71	Neosho, MO

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EXHIBIT IV-11 (Cont'd)

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B. Summary of Institutional Training Program

Sponsor/Subcontractor	No. of Trainees	Starting Date	Training Location
Charles County Community College	40	1/25/71	LaPlata, MD
Kirkwood Community College	60	2/ 1/71	Cedar Rapids, IA
Atlanta Area Technical School	40	2/22/71	Atlanta, GA
Delaware State College	40	2/ 1/71	Dover, DE
Columbus Technical Institute	40	5/ 3/71	Columbus, OH
Brevard Community College	40	6/21/71	Cocoa, FL
Delgado Junior College	40	6/21/71	New Orleans, LA
Penn Valley Community College	40	6/22/71	Kansas City, MO
Miami Dade	20	9/ 7/71	Miami, FL

C. Summary of Public Service Careers Program

Sponsor/Subcontractor	No. of Trainees	Starting Date	Training Location
State Planning & Grants Div.	100 entry 100 upgrade	12/70	Columbia, SC
North Central Texas Council of Governments	90 entry 71 upgrade	11/70	Arlington, TX
Texas Water Quality Board	100 entry 100 upgrade	1/71	Austin, TX
Public Works Comm.	25 entry 23 upgrade	1/71	St. Thomas, VI
Pollution Abatement Div.	50 entry 50 upgrade	1/71	Richmond, VA
Wisconsin Board of Vocational, Technical & Adult Education	50 entry 50 upgrade	1/71	Madison, WI

D. Summary of Transition Training Program

Sponsor/Subcontractor	No. of Trainees	Starting Date	Military Installation
Charles County Community College, LaPlata, MD	70	11/ 9/70	Ft. Belvoir, VA
Fayetteville Technical Institute, Fayetteville, NC	70	12/ 7/70	Ft. Bragg, NC
El Paso Independent School District, El Paso, TX	70	12/ 1/70	Ft. Bliss, TX
Central Texas College, Killeen, TX	70	1/18/71	Ft. Hood, TX
Orange Coast Community College, Costa Mesa, CA	30	1/11/71	El Toro Marine Base
Contra Costa Community College District, Martinez, CA	40-48	9/ 7/71	Treasure Island, NAS, CA
Sinclair Comm. College, Dayton, Ohio	40-48	9/ 7/71	Wright-Patterson AFB
Clover Park Voc. Tech. Inst., Tacoma, Washington	30	7/12/71	McCord AFB
San Diego Comm. College Dist., San Diego, CA	40-48	8/16/71	San Diego NAS
Sumter Area Tech. Ed. Center, Sumter, SC	40-48	7/26/71	Shaw AFB

(2) Institutional Training

Scope and Activities of the EPA Institutional Training Program. Another potential source of manpower for wastewater treatment operation is provided through institutional training. This type of training is often referred to as "train now, employ later." Although a number of these programs (such as the Concentrated Employment Program) have been available to the unemployed, their orientation has been generalized and multioccupational. EPA/OWP administers a national institutional water pollution control training program with funds being provided by interagency agreement with DOL and HEW. This agreement was negotiated in FY 1971 to initiate nine pilot regional manpower training centers.

Traditionally, institutional training provides basic education in the classroom for the unemployed. A distinctive feature of the EPA program is that half of the instruction is practical "hands-on" training in a wastewater treatment plant, even though the trainee is not employed by the plant. The program is still in the first year of operation, and each local sponsor is showing improvement in the system of recruiting trainees, conducting courses, and providing employment opportunities for graduates.

The program is conducted by community colleges or vocational training schools and currently provides for a total enrollment of 360 persons. Each institution enrolls 40 trainees referred by the State Employment Service (20 during the first 22-week training cycle and the balance during the second 22-week cycle). Cooperative arrangements are effected between the training institutions and publicly owned local waste treatment facilities for the "hands-on" portion of the program.

Trainees receive 440 hours of classroom instruction covering basic education related to plant operations, operating theory and technique, and 440 hours of hands-on training in a treatment plant. State Employment Services are urged to recruit Vietnam veterans whenever possible. The training costs approximately $734,000, plus an additional $700,000 allotted by the DOL for training and subsistence allowances.

The second section of the program will enroll the balance of the trainees, who will complete training early in 1972. A summary of program activities is included in Exhibit IV-11.

Assessment of the EPA Institutional Training Program. The Institutional Training Programs are providing an excellent source of supply for trained personnel at thy entry level. Trainees referred to the program through local Employment Service Offices meet MDTA eligibility guidelines, and a substantial number are Vietnam war veterans. All are seeking vocational training and career job opportunities.

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Although the program is not yet 50 percent complete, a review of the first graduating classes indicates a high degree of trainee completion and job placement. Of the 174 enrollees in the first phase of the program, 51 had completed training as of 15 September 1971, and 100 were still in training. While 45 of the 51 graduates have been referred to job opportunities, it is too early to determine the actual number accepting job offers; however, it is thought to be substantial.

There are numerous representative examples of the success of the program. Five trainees from the Virgin Islands completing the course conducted by the Atlanta Area Technical School received immediate employment with the Department of Public Works in the Virgin Islands. All of the first section (16) from the Kirkwood Community College in Cedar Rapids, Iowa, passed the entry-level State Certification Examination. Job recruiters were contacting the trainees prior to their completion of the course, and all of the trainees were referred to jobs in Illinois, Iowa, and Minnesota. The City of Dubuque, Iowa, hired three graduates, one as a laboratory technician and two as plant operators.

EPA/OWP is now disseminating information about the availability of trained graduates from these programs so that personnel recruiters in need of such manpower can schedule visits to the campuses of sponsoring institutions. As information on the availability of such graduates reaches proper officials, it is expected that the demand will far exceed the current supply.

A second institutional training program is now being discussed with officials of DOL and HEW to continue and expand current efforts.

(3) Public Service Careers (PSC)

Scope and Activities of the EPA Public Service Careers Program. With the initiation of the Public Service Careers Program, and specifically its Plan "B," which is tailored to channel funds from Federal to State and local agencies, EPA negotiated an interagency agreement with DOL to train 922 disadvantaged persons newly or previously employed in wastewater treatment plants. Four states--Texas, Virginia, South Carolina, Wisconsin--and the Virgin Islands were awarded contracts to participate in the EPA program, which began in November 1970 and will cost $1,700,000.

EPA has approached the PSC program with the overriding thought that men are poor because they are disadvantaged, and that if the disadvantage can be removed, they will be able to overcome poverty now and in the future. In keeping with this approach, employers participating in EPA's PSC program have been encouraged to develop vacancies for disadvantaged persons by moving presently employed persons upward and releasing their former jobs for new entry-level trainees. Almost all sponsoring agencies have subscribed to the theory of upward mobility for current employees and have secured agreement from employers to furnish vacancies for entry-level jobs.

This approach has resulted in an initial disproportion of entry to upgrade training. Agreement between DOL and the EPA/OWP called for a total of 490 entry-level trainees and 432 upgrade trainees. As of 31 August 1971, total enrollment of the program was 876, of whom 354 were at the entry level and 522 were being trained for upgrade positions.

In addition to providing training and supportive services, program sponsors are responsible for finding existing job vacancies within their jurisdictional limits and for cooperating with regional, county, and municipal governments in filling these positions.

A summary of PSC program activities is included in Exhibit IV-11.

Assessment of the EPA Public Service Careers Program. As previously discussed, the overall objective of the Public Service Careers Program is to provide, through training, permanent employment for disadvantaged persons in governmental agencies at all levels and to stimulate the upgrading of current employees.

EPA's PSC Program has been extremely successful. As of 31 August 1971, a total of 876 trainees had been enrolled. Although contract commitments call for a total of 922 trainees, it appears this will be exceeded by 40 percent upon contract termination date, 30 June 1972. Terminations have been at a minimum, with only 7 percent reported as of this date.

Great emphasis has been placed on recruiting young persons for training in entry-level positions. Currently approximately 51 percent of the entry-level candidates are under 30 years of age. Projects report a total of 130 black enrollees and 82 with Spanish surnames. There are 15 female enrollees, with 11 receiving upgrade training. Thirty-three of the entry-level enrollees are handicapped, and 246 have less than a high school education.

(4) Transition Training

Scope and Activities of the EPA Transition Training Program. Recognizing the potential manpower for water pollution control represented by returning servicemen who already have basic skills as a result of their military experience and training, EPA negotiated an interagency agreement with the Departments of HEW and Defense to establish a program of transition training in entry-level operator positions. The purpose of the Transition Training program is to provide veterans with marketable skills for employment in wastewater treatment plants through retraining before discharge from the service.

Over 500 servicemen will be trained in this program, which began during November 1970. Basic education and OJT are provided by 10 joint facilities (military institutions with or near wastewater treatment plants and nearby academic institutions). Duration of the course is determined by each service. Trainees at Army bases are given 240 hours of coupled OJT and those at Air, Navy, and Marine bases are given 480 to 640 hours. Total cost of the program--including the cost of instructors, supplies, equipment, program administration and supervision, and job location assistance--is $470,807. EPA Transition Training Program activities are included as part of Exhibit IV-11.

In addition to managing the national contract for Transition Training, EPA performs several other related functions. First, it coordinates efforts to place successful trainees in water pollution control plant jobs upon their separation from military service. (About 70 percent of the servicemen who have already completed the Transition Training Program have gone directly into operator trainee jobs in wastewater treatment plants or into advanced water pollution control training programs.)

EPA also has a responsibility to provide job counseling for veterans with whom they come in contact or who contact EPA. As shown on the chart at the end of subsection III-B-3-c, several options are open to veterans for training in water pollution control. In the future, EPA intends to encourage veterans to further their training--either by enrolling in an Institutional Training Program or a junior or community college offering a one- and two-year curriculum in water and wastewater technology or by seeking employment in a treatment plant offering EPA- or State/local-sponsored coupled OJT--in order to qualify for higher level jobs.

Second, EPA--through direct contact with VA offices--encourages the Veterans Administration to channel veterans into water pollution control occupations and training programs. For example, it has distributed guidelines to VA State agencies which approve wastewater treatment plant operator training programs, recommending the following:

--Option I: Enrollment in an EPA-sponsored operator training program if the trainee is within commuting distance of one of EPA's training projects.

--Option II: Enrollment in a training project equivalent to the EPA-sponsored program, which may be sponsored by a State or local water pollution control agency, if the trainee is within commuting distance of the training project.

--Option III: Enrollment in a correspondence course which could be administered by the State water pollution control agency and/or EPA's Manpower and Training regional and headquarters organizations if no training projects are available or accessible under Options I and II.

Under Option III, basic education and operator theory training could be provided by a correspondence course manual for wastewater plant operators prepared by Clemson University or Sacramento State University. On-the-job training in plant operating techniques could be provided in accordance with an OJT-apprentice-type training schedule prepared by EPA. The schedule covers a 13-month program for graduates of the Transition Training Program and an 18-month program for veterans who did not receive transition training. OJT instruction would be provided by an experienced, qualified waste treatment plant operator who would also coordinate and relate the correspondence course training with the on-the-job training.

Third, EPA encourages employers to develop in-house OJT programs for waste treatment plant operators and provides guidelines for curriculum and training materials.

Assessment of the EPA Transition Training Program. Of the 277 enrollees in programs to date, 108 are still in training. One hundred fifty-three have completed the program, with 145 given opportunities for employment. Eight are seeking additional training. Three graduates were provided job opportunities but decided to return to civilian employment in various jobs outside the field of pollution control.

Several trainees have excelled in their jobs, due to the high level of training they received under EPA Transition Programs. One trainee, a graduate of a 240-hour course at Fort Bliss, Texas, scored the highest grade among 50 applicants for a position in the El Paso Public Utilities System. Included in the 50 applicants were men with as much as two years' previous experience.

In addition to the high degree of satisfaction expressed by the trainee is the even greater appreciation of various employers throughout the United States, Puerto Rico, and Canada. Several employers have commented on the maturity, dependability, and competence of the trainees graduating from this program. The application of these highly trained personnel guarantees a superior level of performance in water pollution control activities.

(5) Assessment of National MDTA-Funded Projects. The four national operator training programs funded by DOL under MDTA have had a positive impact, demonstrating that the disadvantaged--the unemployed, the underemployed, and the minority groups--can be successfully trained for a variety of water pollution control jobs and that application of the career ladder concept can be highly effective in improving public service in this area. The establishment and implementation of these programs, however, has inevitably posed certain problems for EPA. First, given the funds for program development, it has been necessary to convince potential sponsors that such training will satisfy an unmet need and that it will be feasible. For example, can the disadvantaged be trained for entry-level operator jobs? Will employers--leery of the connotations of "disadvantaged"--resist programs for their training and

employment? Experience with the programs thus far, particularly coupled OJT and Public Service Careers, has demonstrated to the State and local agencies both need and feasibility. Indeed, they have been vital in supplementing the independent and collective efforts of the states and localities to provide entry and upgrade training for lower level operators.

A second area of concern has been how to find and train instructors for the programs once they have a sponsor. In all cases, the emphasis has been on seeking out high-level operators who can be trained to be educators, rather than educators who must be trained in operational theory and technique. The advantages of such an approach are obvious: instructors with successful experience in the field are well-grounded in waste treatment plant operations and qualified to perform OJT, thus ensuring program continuity through coordination of basic education and theory with practical application.

Initially, EPA headquarters staff used selected portions of the Area Manpower Instructor Development System (AMIDS) to train instructors for the MDTA-funded operator training programs. Using the AMIDS package as a generalized base, the EPA staff subsequently developed its own tailored program, referred to as Phase I Instructor Training. The Phase I program essentially represents a refinement of AMIDS tailored to the water quality environment. It is now offered as the basic education course for instructor development under the EPA Technical Training Program.

Continuation of the four MDTA-funded operator training programs depends on annual funding by DOL and HEW. If program funding does not continue at existing or expanded levels through the mechanisms provided, then some other mechanism must be sought--either through a set-aside or an interagency agreement--to obtain the funds required by EPA. Without the assurance of continued and expanded funding, uncertainties will exist and planning for meeting future operator training needs will be hampered.

b. The Pilot Program. Because the focus of MDTA has been on basic education and entry-level skills for the disadvantaged entering the wastewater treatment field and on skills improvement for the underemployed at the lower operator levels, certain training needs of operators and technicians remain unmet by the DOL programs. These needs include:

- Alternative entry and upgrade programs for lower level operators who do not meet the eligibility requirements of or who are not reached accessibly by the MDTA programs.
- A comprehensive program for upgrading and updating the managerial and technological skills of technicians and higher level operators and to increase the capacity of others to do so.

In addition, the MDTA programs do not address a number of peripheral concerns such as innovative techniques and approaches to operator training, advanced instructor training, and curriculum development. They also do not address the more immediate need for qualified technicians and higher level operators.[1]

To provide a more comprehensive approach to training in wastewater treatment plant operations, subsection 5(g)(1) of the Act authorized EPA to develop:

> "a pilot program, in cooperation with state and interstate agencies, municipalities, educational institutions, and other organizations and individuals of manpower development and training and retraining of persons in, or entering into, the field of operation and maintenance of treatment works and related activities."

The Pilot Program is intended to supplement--not supplant--other manpower training programs such as those funded under MDTA. Its purpose is to demonstrate that with the use of innovative techniques and approaches, management training and advanced training in wastewater treatment operations will satisfy a need presently unmet at the State and local levels in order to accomplish these objectives:

--Provide an adequate supply of trained personnel to operate and maintain existing and future wastewater treatment works and related activities.

--Enhance substantially the proficiency of those engaged in such activities.

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[1] Grants and Scholarship Programs, discussed subsequently, will provide benefits only over the long term, and funding for these programs has been limited.

Using funds from the FY 1971 supplemental appropriation, EPA initiated three programs under the pilot program: (i) advanced instructor training, (ii) specialized training in advanced wastewater treatment, and (iii) grants for special State projects. The first two programs represent compelling national needs; the third represents the most compelling needs of individual states.

The total number of trainees to be supported under each project and the approximate cost (amount of grant) of each project is as follows:

Program	Total Number of Trainees	Total Amount of Grant
Advanced Instructor Training	50	$ 39,174
Specialized Training in Advanced Wastewater Treatment	190	183,114
Grants for Special State Projects	2,945	734,416
TOTAL	3,185	$956,704

Summary descriptions of each program appear in Appendix B.

(1) Advanced Instructor Training. Instructors of the basic operator training courses also required upgrade training in advanced teaching techniques to instruct these and higher level training programs. A pilot project was initiated to satisfy this compelling need.

This project, referred to as Phase II Instructor Training, provides advanced education techniques to operator training instructors who have already learned basic education skills. It represents a refinement of the basic Phase I training course currently offered under EPA's Technical Training Program. The course emphasizes motivation, sensitivity training, design of effective instructional techniques, and evaluation and utilization of learning resources.

A grant of $39,174 was awarded to Drake University to develop and conduct the Phase II training, which began in June 1971. Between 40 and 50 instructors have enrolled in the course, and two sessions have been completed. Participation in the course provides the advantages of contact with professional educators, more sophisticated education skills, and the opportunity for both college credit and upgrading of instructor credentials.

(2) Specialized Training in Advanced Wastewater Treatment. When the Pilot Program was authorized, few programs on advanced wastewater treatment operations were offered at the State and local levels. EPA awarded two grants under the Pilot Program for development of two advanced experimental and demonstration projects to provide intensive technical training in the operation of wastewater treatment processes for advanced waste treatment operators, treatment plant supervisory personnel, public works department personnel, and others with a need for such training. Both recipients of these grants, the Tennessee Department of Public Health and the Texas Engineering Experimental Station, were selected on the basis of the unique contribution they could make to the program. Both contractors have well-qualified staff personnel capable of conducting the programs. The total cost of the two advanced wastewater treatment programs, including trainee subsistence and travel, will be approximately $183,000. Each of these programs is discussed briefly below.

Tennessee Program. The State of Tennessee is in an area currently moving from primary to secondary treatment, and the State Department of Public Health was in the process of establishing a training laboratory, usable for such courses, at the time the grant was awarded. The program is regional in concept and is designed to reach 60 trainees from states in the southeast region of the United States. Enrollees receive four weeks of classroom instruction, followed by on-site plant visits. Participants from the State of Tennessee will receive additional on-the-job training over a four-week period following the classroom phase of the program. The pilot program will be used to develop a blueprint for similar regional and State programs.

Texas Program. The Texas Engineering Experimental Station, with a large research and development investment, is in one of several states moving from secondary to tertiary treatment; it already had a training laboratory at the time of the grant award. The Texas program was regional in concept at inauguration but was designed to become national as it developed. The program will provide training in advanced wastewater treatment to 130 participants from several sections of the nation, especially for plant personnel from systems utilizing (or soon to utilize) advanced treatment processes. Courses will be conducted in several locations throughout the nation and at the Texas Experimental Station.

(3) Grants for Special State Projects. A wide range of operator training needs had been identified by State water pollution control and other public agencies across the country. Given the availability of funds under the Pilot Program, the states were asked to suggest innovative projects representing their most compelling needs. Each EPA region then selected at least one training project for development and implementation, based on the following criteria:

--Replicability.

--Geographic diversity.

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--Potential for problem-solving.

--Coverage (for example, management training for decision-makers, electrical and instrumentation courses, correspondence study programs, and so forth).

Final selection of projects for award was made by EPA/OWP headquarters staff, based on (i) regional recommendations, and (ii) the project's potential for filling a recognized void in training activity. Further, consideration was given to the overall potential of the projects to demonstrate comparative approaches to training.

Twenty-four grants were awarded to 18 states, one region (New England), and Puerto Rico for development of operator or operations-related training and information programs. These projects cover the following major areas of need among the states:

(i) Management training for first-line supervisors to expand and upgrade administrative skills of persons involved in operation and maintenance of wastewater treatment facilities to improve overall plant efficiency and personnel performance.

(ii) Phosphorous removal training programs. These programs must assist in demonstrating feasible removal processes as states are now legislating for removal by the end of 1972.

(iii) Electrical and instrumentation courses for plant personnel to provide expertise in preventing plant shut-down as a result of minor electrical and instrumentation problems. In other words, preventive maintenance training in these critical areas.

(iv) General skill improvement training for higher level plant personnel (operators and technicians) that cannot be trained under U.S. Department of Labor programs.

(v) Information and orientation seminars for local officials and policy decision-makers to demonstrate their unique function in the solving of pollution problems in their own sectors.

(vi) Correspondence study programs to reach plant personnel in rural (and hard to reach) areas unable to participate in ongoing training programs. For this purpose, the Environmental Protection Agency has, through a grant with Sacramento State College, developed a correspondence field study program and is making it available (at no cost) to 2,000 enrollees.

Exhibit IV-12 provides the number of grants awarded for the development of programs to meet these needs.

EXHIBIT IV-12
NUMBER OF GRANTS AWARDED FOR SPECIAL STATE PROJECTS BY PROGRAM COVERAGE

Program Coverage	Number of Grants Awarded
Training	
• Skills improvement and upgrade of operator personnel	10
• Proficiency improvement of operators and personnel engaged in operator-related activity	1
• Training of entry-level personnel and existing operators; skills improvement of laboratory personnel	1
• Training in laboratory techniques	1
• Training in phosphorous removal techniques	1
• Mobile laboratory for skills improvement of operators and personnel engaged in related activity	1
• Field training unit for operator training	1
• Training in planning and supervision of OJT, in-service and external training for operators and supervisors; training of instructors, teachers, and plant supervisors in the conduct of training courses; instruction for health department and other regulatory inspectors in conduct of operations and maintenance inspections	1
• Supervisory training	1
• Management training	2
• Information-oriented seminars for State and local officials; training for regulatory personnel	1
• Orientation seminars for local officials and citizens	1
Curricula & Materials Development	
• Development and implementation of curricula for water pollution control personnel	1
• Development of standard operating procedures and technical training materials	1

Each state conducts its own training programs or contracts for its performance. EPA provides technical assistance, particularly for developing curricula and training materials.

Approximately 2,945 persons will be trained under these programs, for a total cost of about $734,416. Program development began during May 1971; training began during the first quarter of FY 1972.

(4) Assessment of the Pilot Program. It is too early to evaluate the Pilot Program, as projects were not initiated until the end of FY 1971. The EPA regional offices are presently developing criteria for assessment of each project, which will be monitored and reviewed monthly. There are early indications that requests for enrollment far exceed the funded capacity to provide training. The pilot projects presently supported by funds authorized under Sections 5(g)(1) represent only a small portion of the needs termed critical by the states.

The limited nature but significant potential of the program was recognized when it was initially proposed. Senator Muskie, in a statement to the Senate in October 1969 indicated:

> The [Public Works] Committee recognizes that a great deal more than a pilot program will be required if Federal funds for sewage treatment plant construction are invested wisely, but it believes that experience with a pilot program would provide a sound base for expanded legislation in the near future.[1]

The Pilot Program is an important step in encouraging, guiding, and financially assisting the states to meet the substantial training needs generated by the accelerated wastewater treatment plant construction program. Because the states have not had, nor do they presently possess, the resources (funds, instructional staff, or training programs) to properly assume this responsibility, the Pilot Program represents the primary vehicle through which the states can build their capacities to help provide an adequately trained work force to protect and effectively utilize this investment.

Toward this objective, the Pilot Program has:

--Established a mechanism to immediately initiate the training necessitated by the accelerated program.

--Provided an initial framework upon which the states can build and for which they can eventually assume responsibility.

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[1] Congressional Record, 7 October 1969, S. 12038.

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c. Technical Training Grants and Scholarships for Undergraduate Study

(1) Scope and Activities of the Undergraduate Technical Training Grants and Scholarships Program. Entry training programs to prepare students for positions as technicians or higher level operators have been woefully inadequate. To help expand programs for preparation of students to enter positions relating to the design, operation, or maintenance of treatment plants and other related facilities, EPA initiated the Undergraduate Training Grants and Scholarship Program.

Section 16 of the Act authorizes the award of:

> . . . grants to or contracts with institutions of higher education . . . to assist them in planning, developing, strengthening, improving, or carrying out programs or projects for the preparation of undergraduate students to enter an occupation which involves the design, operation, and maintenance of treatment works and other facilities whose purpose is water quality control.

The objectives of this section are:

- To plan, develop, or expand training programs at this level.
- To train and retrain faculty.
- To support innovative and experimental programs of cooperative education.
- To develop and research teaching materials and to plan curriculum.

Section 18 authorizes the award of "scholarships for undergraduate study by persons who plan to enter an occupation involving the operation and maintenance of treatment works."

Although a limited appropriation has precluded initiation of the scholarship program, two areas of training have been addressed under Section 16:

- Training of qualified high school students at two-year institutions in the operation and maintenance of waste treatment and related facilities.

- Improvement of the training of junior and senior bachelor degree engineering students in the design of waste treatment facilities at four-year colleges.

Training to meet the first area will produce qualified entrants for senior operator and technician positions. This training complements that performed under the Pilot Program (for skill improvement of currently employed operators and technicians) and MDTA training (entry and upgrade training for lower level operators). It is intended to fill the gap between lower level operator training and four- or five-year professional training, particularly at the technician and senior operator levels. Under this program, training grants have been awarded to technical schools, junior colleges, and similar institutions to develop and test new approches to curricula development.

In the past, and even still in many jurisdictions (units of government), plant supervisors must have a B.S. degree. There is, however, a shortage of personnel with this qualification, particularly in medium-sized wastewater treatment plants where salaries may be too low to attract baccalaureate professionals. Further, often the job responsibilities of plant supervisors do not require the B.S. degree. The State of New York, for example, recently downgraded the educational requirements for certification of plant supervisors to a two-year Associate of Science degree.

In anticipation of other jurisdictions adopting similar requirements, EPA has used the funds appropriated under Sections 16 and 18 of the 1970 Water Quality Improvement Act to assist educational institutions and students involved in technician-oriented training programs. Both sections of the act are intended to alleviate a critical shortage of skilled engineering aides, scientific technicians, and senior treatment plant operators. Grants and contracts with two-year technical schools and community colleges will prepare high school graduates for supervisory or senior level operator or technician positions in wastewater treatment plants, advanced treatment systems, and regulatory agencies.

Sections 16 and 18 have not been fully implemented as a result of budgetary constraints. Although $12 million was authorized for FY 1970 and $25 million for FY 1971 and FY 1972, no funds were appropriated for 1970, only $331,000 was appropriated for 1971, and $346,000 for 1972.

In order to save a year in initiating its program of financial assistance, EPA in FY 1971 awarded Clemson University, Clemson, South Carolina, a grant for $54,017 out of FY 1970 Professional Grant monies--originally scheduled for support of more advanced training. The purpose of the grant was twofold:

--To help establish criteria for the selection of undergraduate institutions offering design, operation, and maintenance training.

--To develop curricula guidelines for two-year post-high-school wastewater technology training programs.

Clemson subsequently received a supplement of $12,737 to develop criteria for the design of engineering curricula pertaining to undergraduate programs oriented to the design of wastewater treatment plants.

The $331,000 appropriated for FY 1971 was used to award grants to seven institutions for further planning and design of the curriculum material and for initiating training programs and/or materials development. Award was based on capability to develop the undergraduate programs and on the availability of trainees to enroll in them.[1]

Three of these institutions (Charles County Community College, Linn-Benton Community College, and the Greenville Technical Education Center) have completed development of program curricula based on the guidelines prepared by Clemson University and have opened their degree programs this fall. Curricula will vary among the institutions but will essentially cover wastewater treatment operations, including classroom theory and "hands-on" training in a nearby cooperating wastewater treatment plant, as well as algebra, chemistry, general biology, ecology, microbiology, hydrolics, practical physics, and several liberal arts courses. About 20 students will attend each program. Graduates will receive an Associate of Science degree and will be eligible--under voluntary or mandatory state certification programs--to be superintendents (plant chiefs) of medium-sized wastewater treatment plants.

(2) Assessment of the Undergraduate Technical Training Grants and Scholarships Program. It is too early to provide a meaningful assessment of effectiveness, as the undergraduate programs are just getting started.

As the shortage of manpower for water pollution control becomes more acute, the importance of senior-level entry training increases because of the entrant's ability to assume responsibilities previously reserved for the professional level. However, budgetary constraints will severely limit the number of undergraduates who will be trained in FY 1972 in the design, operation, and maintenance of water treatment works and related facilities. With construction grants presently funded at $2 billion annually (which may be increased to $3 billion), and with a growing manpower requirement to service these facilities, as established in Part II, the monies for activities conducted under Section 16 and 18 must be increased.

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[1] These awards are listed by State, institution within State, and amount awarded in the EPA publication, Water Quality Control Training Grants, 1971 Grant Awards.

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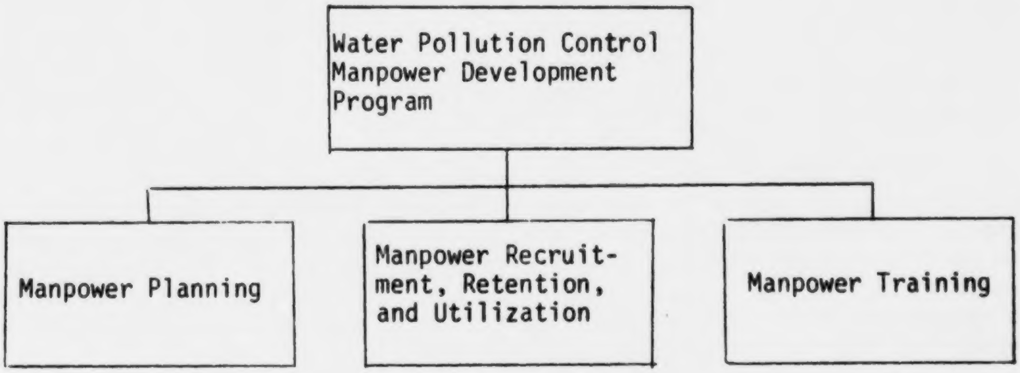
PART V
CONCLUSIONS AND RECOMMENDATIONS

Summary of Conclusions

Acting pursuant to the Federal Water Pollution Control Act, EPA administers the Federal Water Pollution Control program. This program includes a broad spectrum of activities related to water pollution control that are conducted in partnership with the states and local governments, private organizations, and other Federal agencies. Generally, the Federal program provides that the states and their subdivisions have primary responsibility for conduct of water pollution control activities, while the Federal Government provides financial and technical assistance to support their efforts. Only when performance gaps are apparent will the Federal Government assume primary responsibility.

All of the program activities require the application of manpower for their accomplishment. Accordingly, one aspect of the Federal program is activities designed to ensure that manpower in adequate numbers and with requisite skills will be available at the times and places needed, that available manpower are effectively and efficiently utilized, and that the members of the labor force find personal satisfaction from their jobs.

This report has focused on these manpower activities. In doing so it has followed the EPA concept of a water pollution control manpower development program with three interdependent units:


Water Pollution Control Manpower Development Program
Manpower Planning
Manpower Recruitment, Retention, and Utilization
Manpower Training

The report responds to the requirement of subsection 5(g)(4) of the Federal Water Pollution Control Act requiring a report to the Congress on manpower and training actions taken under subsection 5(g) and comments on the effectiveness of other training programs in the field. It also provides estimates of future manpower and training needs.

In summary, Part II of this report points out that EPA has conceptualized a method for forecasting the supply and demand for water pollution control manpower. This method is one component of the overall manpower planning program. As conceptualized, the planning program is intergovernmental and interagency, with the states having the pivotal role. It includes the needs of both private and public employers. The system forecasts manpower and enters update and upgrade training needs by occupation, labor market location, and time frame. Under the other planning program component, action plans are then developed at all levels to fulfill these needs.

EPA has initiated the development of the planning tools and base data necessary to operate the program. The program is not yet fully operational but is approaching the stage of field installation. This necessitates providing State and local personnel with substantial training and technical assistance in its application, since presently the State and local governments have limited capacities for manpower planning. The report concludes that EPA should complete implementation of the planning program since its outputs are necessary as a basis for rational manpower and training actions in this sprawling and institutionally complex industry.

The report goes on to set forth an interim forecast of manpower and training needs through 1976, which has been specially developed for this report pending full implementation of the manpower planning system. While this interim forecast is subject to some questions because of data qualifications, EPA believes it is a good indicator of the order of magnitude of the manpower and training needs. In summary, this forecast is presented in Exhibit V-1. The anticipated rapid growth of the water pollution control work force is shown in Exhibit V-2. The forecasted training requirements are set forth in Exhibit V-3.

The largest increase indicated by the forecast is for more operators. The increase projected in the number of waste treatment plants coupled with the increased sophistication of treatment processes are expected to result in an increase in operator training requirements as well. EPA observations and a report by the General Accounting Office (GAO) indicate that the effectiveness and efficiency of existing treatment plants is already impaired by understaffing and undertraining of operators.

The report further concludes that there will be a need for more sanitary engineers, primarily because of the increasing technological sophistication of the water pollution control process. Further, it concludes that specialized water pollution control training is necessary in substantial quantity for other professionals entering the field. Also there is a substantial demand for update training for all professionals.

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EXHIBIT V-1
ADDITIONAL MANPOWER REQUIRED BY 1976*

Personnel Category / Sector	Nongovern-mental	Local	State	Federal Non-EPA	EPA	Personnel Category Total 1976
Professional	10,200	1,300	3,400	1,300	600	16,800
Technician	18,400	1,200	400	200	200	20,400
Operator	33,300	8,900	--	1,400	--	43,600
Other	10,400	11,700	800	400	600	23,900
TOTAL**	72,300	23,100	4,600	3,300	1,400	104,700

*The bases for these figures are set forth in Part II-D of this report.

**An undetermined portion of this total will be employees assigned on a part-time basis to water pollution control activities.

EXHIBIT V-2
LABOR FORCE GROWTH 1971 TO 1976

Personnel Category	1971 Manpower Engaged	1976 Manpower Requirements	Percentage Increase
Professional	25,400	42,200	66%
Operator	49,300	92,900	88%
Technician	26,900	47,300	77%
Other	47,800	71,800	50%
TOTAL	149,400	254,200	70%

EXHIBIT V-3
FORECASTED TRAINING REQUIREMENTS
(Average Annual Load--1972 - 1976)

Sector / Personnel Category	Nongovernmental		Local		State		Federal Non-EPA		EPA		TOTAL	
	Entry	Update	Engry	Update	Entry	Update	Entry	Update	Entry	Update	Entry	Update
Professional	2,960	9,140	500	2,480	880	1,920	520	2,640	160	1,260	5,020	17,440
Operator	8,260	16,020	3,480	17,080	-	-	520	2,460	-	-	12,260	35,560
Technician	5,160	14,860	480	2,300	100	260	140	960	40	280	5,920	18,660
Other	2,580	3,280	400	1,260	-	-	60	280	180	-	3,220	4,820
TOTAL	18,960	43,300	4,860	23,120	980	2,180	1,240	6,340	380	1,540	26,520	76,480

With regard to technicians, the report notes that there will be an increased demand for upper level, highly trained technicians and that substantial update training for the present work force will be required.

Part III of the report addresses the recruitment, retention, and manpower utilization activities undertaken by EPA to fulfill manpower and training needs. It notes that these activities have been largely adjuncts of programs financed by the Manpower Development and Training Act or by EPA research and development funds, rather than by funds authorized under subsection 5(g). The report concludes that when these programs are taken together, they probably only begin to reap the benefits in terms of reductions in manpower and training requirements that could be obtained by the systematic and widespread application of such techniques by all water pollution control employers.

Of special note, Part III examines operator certification. In a review of the current situation, it notes that 47 states now have certification requirements of some kind, but in only 31 is it mandatory. Further, the standards for certification vary substantially from state to state. It also notes that operator certification is of benefit in various ways to the operators, to the employers, and to the public. Therefore, EPA intends to encourage mandatory certification by all states.

Part IV of the report reviews the water pollution control training activities of EPA and of others--including educational institutions, associations, private industry, local agencies, State agencies, and Federal agencies. The non-EPA organizations carry on this training for all classes of personnel in a random pattern that defies brief summarization. However, as the report makes clear, in total these non-EPA sources do not conduct sufficient training to meet overall manpower and training needs. Further, in respect to "one-time educational efforts"--such as the development of curricula and training materials--the non-EPA organizations tend to be inefficient because of overlap of efforts and results.

As Part IV goes on to detail, under the authority of the Federal Water Pollution Control Act [particularly subsection 5(g) and Section 16] and, with regard to operator training, as an agent of other Federal departments, EPA has mounted programs in cooperation with State water pollution control agencies to fill the training gap for all categories of personnel. Exhibit V-4 outlines these programs and shows EPA's contribution to each program.

The report concludes that generally these programs have been successful in providing well trained manpower for water pollution control. Collectively, they represent a functioning mechanism thrusting in the right direction.

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EXHIBIT V-4
SUMMARY OF EPA TRAINING PROGRAMS

Program	EPA Authority	EPA Contribution
Professional Training Grants	Subsection 5(g)(3)(A) of the Federal Water Pollution Control Act	Financial support to educational institutions for graduate-level programs in water pollution control.
Research Fellowship	Subsection 5(g)(3)(B) of the Federal Water Pollution Control Act	Awards to graduate students for specialized research training in water pollution control.
Direct Technical Training	Subsection 5(g)(3)(C) of the Federal Water Pollution Control Act	Direct training and training support for others in technical matters relating to the causes, prevention, and control of water pollution.
Technology Transfer	Subsection 5(g)(3)(C) of the Federal Water Pollution Control Act	Direct training to practicing professionals, public decision-makers, conservation groups, and the general public.
MDTA		
Coupled OJT	Agent for the Departments of Labor (DOL) and Health, Education, and Welfare (DHEW) under the Manpower Development and Training Act (MDTA)	Program administration for entry-level operator training.
Institutional Training		
Public Service Careers	Agent for DOL under MDTA.	Program administration for entry-level operator training.
Transition	Agent for DHEW and the Department of Defense.	Program administration for entry-level operator training.
Pilot Program	Subsection 5(g)(1) of the Federal Water Pollution Control Act	Direct training, financial support, and training support for update and upgrade operator training.
Undergraduate Training Grants	Section 16 of the Federal Water Pollution Control Act	Financial support to undergraduate institutions to conduct programs in water pollution control; facilities design and facilities operation and maintenance.
Undergraduate Scholarships	Section 18 of the Federal Water Pollution Control Act	Awards to undergraduate students for study leading to careers in the operation and maintenance of wastewater treatment facilities.

APPENDIX A
MANPOWER AND TRAINING NEEDS RESULTING FROM OTHER SOURCES OF WATER POLLUTION

Thermal Pollution

The growing demands for electric power continues to require a tremendous expansion of power-generating facilities. Water is used in the production of almost all electric power now generated--whether hydroelectric, fossil-fueled, or nuclear-powered plants. Two of these generating methods, fossil- and nuclear-fueled steam electric plants, produce large amounts of waste heat that causes thermal pollution.

Installation of facilities such as long discharge lines or cooling towers to control thermal pollution will affect cost factors and require more space for the plant. The increasing use of nuclear power adds another potential hazard to the environment--radiation.

More stringent controls on the discharge of heated effluents and a greater research effort to improve thermal standards and abatement technology are expected to ensure compliance with water quality standards. Additionally, today EPA, the Atomic Energy Commission, and the Department of Health, Education and Welfare, are working together to develop standard radiological criteria for water. Presently there are nearly 2,000 private power plants, 1,000 municipal plants, 140 power distribution and State plants, 170 Federal plants, and 1,480 public and cooperative plants, for a total of nearly 4,800 power plants. Future environmental efforts in this area will undoubtedly require additions to engineering departments and scientific research staffs. Nevertheless it is conservatively estimated that presently, 3,000 professional and 3,000 blue-collar workers require varying degrees of in-depth thermal pollution control training and thousands of others require short-course training.

Feedlot Pollution

Both the increasing number of animals raised and the modern methods of raising these animals contribute to the increased pollution of waters from animal waste. Feeding operations for beef cattle, poultry, and swine, along with dairy farms, are the major sources of actual or potential water pollution from animal wastes; they contribute approximately 1.7 billion tons of waste per year, a good percentage of which reaches our waterways. A number of waste handling and control methods have recently become available which vary widely in complexity and cost. Many States are just beginning to survey feedlot and other agricultural operations to determine the pollution potential and necessary measures to deal with the problem. Projects have been initiated with the Department of Agriculture to demonstrate available techniques for treating runoff from animal feeding operations and for preventing its discharge to receiving waters.

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Presently there are 3,400 feedlots of sufficient size to warrant a minimum of one individual full-time per feedlot, fully cognizant and totally responsible for implementation of effective methods and techniques to control water pollution. Additionally, many thousands of other agricultural personnel directly or indirectly involved in animal raising on intermediate (33,000) and small (105,000) feedlots will require short-course training in effective measures to prevent water pollution. Most training will be conducted by the agriculture extension services of the Federal and State governments.

Other Agricultural Wastes

There is an increasing concern about the short- and long-term environmental effects of runoff from farm lands which contains a variety of chemicals, including pesticides, herbicides, insecticides, and fertilizers. Although soil conservation methods have made some in-roads in controlling runoff, much is left to be done. A number of Federal agencies, in cooperation with State and local authorities, are working on research projects devoted to the search for chemical or biological control methods which will sustain agricultural productivity while reducing the possibility of environmental damage and destruction of aquatic life and wildlife. Some methods to control leaching by irrigation, such as lining canals, are becoming available, and in some areas the possibility of using desalination plants is being studied. Overall, however, the water quality problems caused by irrigation return flows are difficult and expensive to control.

The Office of Pesticides Programs in EPA is developing the scientific knowledge necessary for the development of water quality criteria for pesticides. This requires increased research on the effects of pesticides and the search for less harmful pesticides, expanded monitoring, investigation to identify critical areas, and closer interagency coordination with the Departments of Agriculture and Health, Education and Welfare. However, with over 30,000 agricultural businesses presently in the U.S., much needs to be done to educate these people in the causes of and solution to agricultural water pollution. Scientists and engineers experienced and educated in abatement and control techniques will make up the backbone of the technology transfer to these businesses.

Mine Drainage

Mine drainage, one of the most significant causes of water quality degradation and destruction of water uses, degrades water primarily by chemical pollution and sedimentation. Acid formation occurs when water and air react with the sulfur-bearing minerals in the mines or refuse piles to form sulfuric acid and iron compounds. Prevention of acid and sediment drainage from mines can be accomplished through renovation of the mineral area. Regrading and revegetation can also be effective means of mine drainage control. Other methods of control may involve hydraulically sealing mines, diversion and/or control of underground drainage, and use of chemicals or biological inhibitors to reduce the formation of acid. Neutralization is the most common method of treating acid drainage. In addition, laboratory studies have shown that an inert gas atmosphere which displaces oxygen will prevent mine acid formation. Mining, civil, and chemical engineers, geologists, and hydrologists are now required to turn their attention to mine pollution control. With an estimated 8,000 operating mines employing nearly 125,000 people, and a similar number of inoperative or closed mines, it is conservatively estimated that short-course, technology-transfer-type training is required for approximately 9,000 mining engineers, inspectors, superintendents, and related professional and blue-collar personnel.

Oil and Hazardous Substances

Dumping and accidental spilling of oil and other hazardous materials continue to increase (with presently approximately 10,000 spills each year), and constitute major pollution threats to the water resources of the Nation. Pollution by oil and hazardous substances may occur in any of our waterways and coastal areas, or on the high seas as a result of deliberate dumping, accidental spills, leaks in pipelines, leaks in drilling rigs or storage facilities, or the breakup of transportation equipment. Federal prevention, control and enforcement activities are provided for under the 1970 Water Quality Improvement Act. In conjunction with development of plans with the Department of Transportation and other Federal agencies to prevent and control oil spills, planning has been undertaken to handle accidents of other hazardous substances. There is a substantial body of conventional, "good common sense" preventative technology and operating practices currently available which are not being fully used. Nevertheless, the technology for containing, removing, disposing of, and cleaning up the damage from spills must be classed as primitive and requires a considerable research effort. Today there are over 125 fully integrated oil companies, 7,000 independent crude oil companies, 250 refineries, and over 30,000 bulk plants employing over 425,000 people.

As the state of the art develops, petroleum and chemical engineers, geologists, hydrologists, and operational and maintenance personnel totalling conservatively between 10,000 and 20,000 in the refining, drilling, and production of oil will require short-course and in-depth types of training over the next five years.

Sedimentation and Erosion

Sediments produced by erosion are the most extensive pollutants of surface water--contributing approximately 2 billion tons of sediment per year. The dirty brown or gray appearance of a river or reservoir after a rainstorm is due to sediments washed in from croplands, unprotected forest soils, overgrazed pastures, or the bulldozed "developments" of urban areas. Sources of sediment are diffuse and therefore often difficult or costly to control. Where feasible, erosion prevention provides the most effective method for sediment control. However, abatement and control will be achieved through improved technology and management practices for controlling this type of pollution, and by State and local enactment of permit and inspection measures at construction sites. Although it is known that in order to control sedimentation and erosion soil engineers, soil conservationists, farm operators, irrigation engineers, construction personnel, and similar types of people will require skill improvement and update training, a realistic estimate of their numbers is not yet obtainable.

Wastes From Watercraft

It has been determined that approximately 46,000 Federally registered commercial vessels, 65,000 unregistered commercial fishing vessels, 1,600 Federally owned vessels, and 8 million recreational watercraft use the navigable waters of the U.S. The potential pollution from just the sewage from these vessels is estimated to be equivalent to the sewage produced by just over 500,000 persons. At the present time, a very small percentage of watercraft are equipped with sewage treatment devices. Other significant pollution from vessels is often evident when ships discharge bilge and ballast water containing oil and a variety of other substances.

The Water Quality Improvement Act provides for Federal performance standards for water pollution control equipment on commercial and private vessels. In addition, procedures to certify the marine sanitation devices to ensure their compliance with the established standards will be required. Federal agencies--including the EPA, the Navy, the Corps of Engineers, and the Coast Guard--are presently developing, testing, and installing packaged treatment and control equipment on Federal vessels. In some cases, this will necessitate pump-out on shoreside treatment facilities. It is conservatively estimated that between 10,000 and 20,000 vessel operators will require formal orientation training in the operation and maintenance of inboard sewage treatment plants and that an additional 2,500 Coast Guard personnel, marine engineers, power squadron leaders, and various State and local marine authority personnel will require varying degrees of advanced training.

APPENDIX B
FEDERAL WASTE TREATMENT FACILITIES DATA SHEET

Capacity (in gallons per day)	Number, Type, and Function of Facility											
	Industrial			Sanitary			Combined			TOTAL		
	P	PS	T	P	PS	T	P	PS	T	P	PS	T
1.0 mgd or more	16	60	0	15	113	0	0	0	0	31	173	0
100,000 to 999,999	9	50	0	52	316	5	1	3	0	62	369	5
10,000 to 99,999	3	13	0	99	623	61	0	6	0	102	642	61
1,000 to 9,999	1	4	0	801	1228	101	0	0	0	802	1232	101
999 and under	20	2	0	3411	2298	8	1	0	0	3432	2300	8
									GRAND TOTALS	4429	4716	175

MGD = Million Gallons per Day

P = Primary Treatment Only

PS = Primary and Secondary Treatment

T = Tertiary Treatment

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APPENDIX C
SUMMARY OF EPA PILOT PROGRAM

I. Advanced Instructor Training

Grantee	Training Site	Amount of Grant	Starting Date	Number of Trainees	Summary of Training Program
Drake University	Des Moines, Iowa	$39,174	6/1/71	50	Improve the instructional skills of trainers; emphasis on motivation, sensitivity training, designing effective instructional practices, and evaluation and utilization of learning resources.
II. Specialized Training in Advanced Wastewater Treatment					
Tennessee Dept. of Public Health	Middle Tennessee University	$81,950	6/1/71	60	Demonstrate innovating and unique training procedures for the operation, maintenance, and control of advanced biological waste treatment processes and facilities. These pilot program training methods will be utilized in developing regional or national programs.
Texas Engineering Experiment Station	Dallas Water Reclamation Research Center	$101,164	7/1/71	130	One-year training program including: 5-day courses in chemical-physical waste treatment processes utilizing a pilot plant for providing intimate operating experience. Three such courses offered to twice as many students in Dallas and two other locations. Special operational instruction in activated sludge and AWT maintenance and control to 20 commuting students from the Dallas/Ft. Worth area.
III. Grants for Special State Projects					
California State Water Resources Control Board	San Marcos, California	$110,390	5/1/71	155	Training of wastewater treatment plant operators and related activity personnel to improve substantially their proficiency in operating, maintaining, supervising, designing, and managing facilities through a "problem-oriented" approach to environmental enhancement. Training site will include an operating wastewater treatment facility.

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Grantee	Training Site	Amount of Grant	Starting Date	Number of Trainees	Summary of Training Program
Central Nebraska Tech. College	Hastings, Nebraska	$30,000	7/1/71	20	Development and implementation of curricula designed to develop adequate and appropriate educational competencies for personnel responsible for the prevention of contamination of water resources by those hazardous materials which endanger human health and environment.
Charles County Community College	LaPlata, Maryland	$30,367	7/1/71	0	A pilot program to develop waste treatment plant standard operating procedures and technical training materials related to waste treatment plant operations.
Charles County Community College	LaPlata, Maryland	$15,111	9/1/71	120	Project A--Seminars for State and local elected officials to provide information concerning water pollution control programs, legislation, regulations, and fundamentals of wastewater plant operations and maintenance, including the need for well-trained personnel to operate the plants. Project B--Training program for State and local regulatory personnel or WPC plant personnel concerning practical aspects of water pollution control and plant operation and maintenance, including WPC plant inspection and evaluation procedures.
Colorado Water Pollution Control Division	Grand Junction, Colorado	$20,835	7/1/71	20	Have a trained coordinator who will organize and conduct a training program for scattered wastewater treatment plant operators utilizing classroom and OJT instruction for 20 trainees. The coordinator will work with the State Vocational Education Department and Community Colleges to assist the program and provide additional training opportunities.
Georgia Water Quality Control Board	Atlanta, Georgia	$31,960	6/2/71	30	Improve the skills and upgrade present wastewater treatment plant operators. The trainee will receive basic education in areas of math, communications, science, and plant unit operations with the goal of adding substantially to the proficiency of persons employed at all levels of waste treatment operations.
Greenville Technical Education Center	Greenville, South Carolina	$16,884	7/1/71	12	This training program, designed for supervisory personnel employed by wastewater treatment facilities, will serve to increase the theoretical knowledge level of the participants, increase their understanding of supervisory responsibilities, and help develop training programs in the individual plants of the Piedmont area of South Carolina.

Grantee	Training Site	Amount of Grant	Starting Date	Number of Trainees	Summary of Training Program
Jefferson County Commission (Engineering Dept.)	Birmingham, Alabama	$20,960	7/1/71	25	Improve the skills and upgrade present wastewater treatment plant operators. The trainee will receive basic education in areas of math, communications, science, and plant unit operations with the goal of adding substantially to the proficiency of persons at all levels of waste treatment operations.
The Kentucky Municipal League	Kentucky State Parks	$ 7,994	7/1/71	20	Educate municipal officials and "decision-makers" as to the importance of water quality control in view of new standards. Students would be shown the importance of well-trained operating personnel in their wastewater treatment facilities in order to meet their obligations in the field of water quality control.
Linn-Benton Community College	Albany, Oregon	$74,753	7/1/71	120	Provide present wastewater treatment plant operators with the perspective and training necessary to make a contribution to the solution of environmental problems caused by modern wastewater treatment plants not being operated and maintained at peak efficiency.
Louisiana State Dept. of Health	Various plants and labs	$26,931	7/1/71	40	Planning and supervision for various OJT, in-service, and external training programs for water pollution control plant operators and supervisors, including CAMPS projects, and prepared operators for certification examinations. Also provides training of instructors, teachers, and plant supervisors in the conduct of water pollution control training courses, and instruction for health department and other regulatory inspectors in the proper conduct of operation and maintenance inspections.
Michigan Dept. of Public Health	Lansing, Michigan	$77,308	6/30/71	150	8 weeks of training on operation, control, and maintenance of phosphorus removal from sanitary wastewater. Two-phase program: Phase A consists of one day (or half day) classroom instruction each week for 7 weeks. Phase B consists of a five-day week on lab instruction of analytical techniques needed for control of the process. Each section will serve the plants within a compact mulitple county area with the classroom instruction presented at a location central to the service area. All lab training will be conducted adjacent to the available dorm and dining facilities.

Grantee	Training Site	Amount of Grant	Starting Date	Number of Trainees	Summary of Training Program
Mobile Water Service System	Mobile, Alabama	$10,000	6/23/71	20	Two 24-week sessions on the operation and maintenance of the electrical equipment control and instruments in use at the Mobile Water Service Waste Treatment and Handling facilities.
New England Inter-state Water Pollution Control Commission	Mobile Lab	$82,665	6/28/71	180	Training of wastewater treatment plant operators and related activity personnel to increase the operating efficiency of existing wastewater treatment facilities and sewage collection systems through the upgrading of skills of present plant employees.
New York State Dept. of Enviornmental Conservation	New York City Buffalo, Syracuse	$31,854	6/14/71	340	Training of 280 Grade II Wastewater Treatment Plant Operators at two-week Grade II Schools and 60 Grade III Wastewater Treatment Plant Operators at one-week Grade III Wastewater Treatment Plant Operators Schools.
North Carolina Dept. of Water and Air Resources (Water Quality Division)	Various colleges	$15,000	7/1/71	30	Increase operating efficiency of existing wastewater treatment facilities through upgrading skills of present plant employees and training that will lead to certification of personnel employed as wastewater treatment operators. (44-week course at community colleges and technical schools.)
Oklahoma City-County Health Dept.	Oklahoma City, Oklahoma	$20,595	6/24/71	25	330 hours of classroom and 70 hours of over-the-shoulder training designed to improve skills of present plant employees in order to obtain optimum operational efficiency.
Piedmont Technical Education Center	Greenwood, South Carolina	$ 2,510	7/1/71	30	Three 8-hour days of concentrated effort in the areas of human asp aspects of management, with emphasis on the human needs of those being managed, increasing human value, making better use of time, how to motivate people, problems of temperament, how to predict human behavior, and individual communication.

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Grantee	Training Site	Amount of Grant	Starting Date	Number of Trainees	Summary of Training Program
Pennsylvania Dept. of Education/ Public Service Institute	Harrisburg, Pennsylvania (various schools)	$23,600	7/1/71	1000	Improve skills of present employees in the wastewater treatment field, necessitated by Act 322, Commonwealth of Pennsylvania Certification Act. Section I--twenty 40-hour classroom/OJT courses; Section II--twelve 20-hours classroom/OJT courses held for Pennsylvania Department of Environmental Resources.
Southwest Technical Institute	East Camden, Arkansas	$40,000	7/1/71	160	A field training unit to carry the training program to the operator in his local area for the purpose of certification as a sewerage plant operator.
University of Kentucky Research Foundation	Lexington, Kentucky	$12,236	7/1/71	10	Train entry-level and existing operating personnel, and improve skills of lab personnel so they can perform required analyses of new or proposed standards.
University of Missouri	Columbia, Missouri	$11,931	6/1/71	300	Series of one-day seminars to orient local officials and citizens regarding the State-local-Federal responsibilities for wastewater management.
Virginia State Water Control Board	Various State labs	$15,000	7/1/71	70	Intensive training in standard sewage plant laboratory techniques and theory for wastewater personnel charged with the responsibility for testing and reporting procedures. Program to be presented at sewage treatment plant labs, 6 hours per week for 10 weeks.